MACHINE DESIGN

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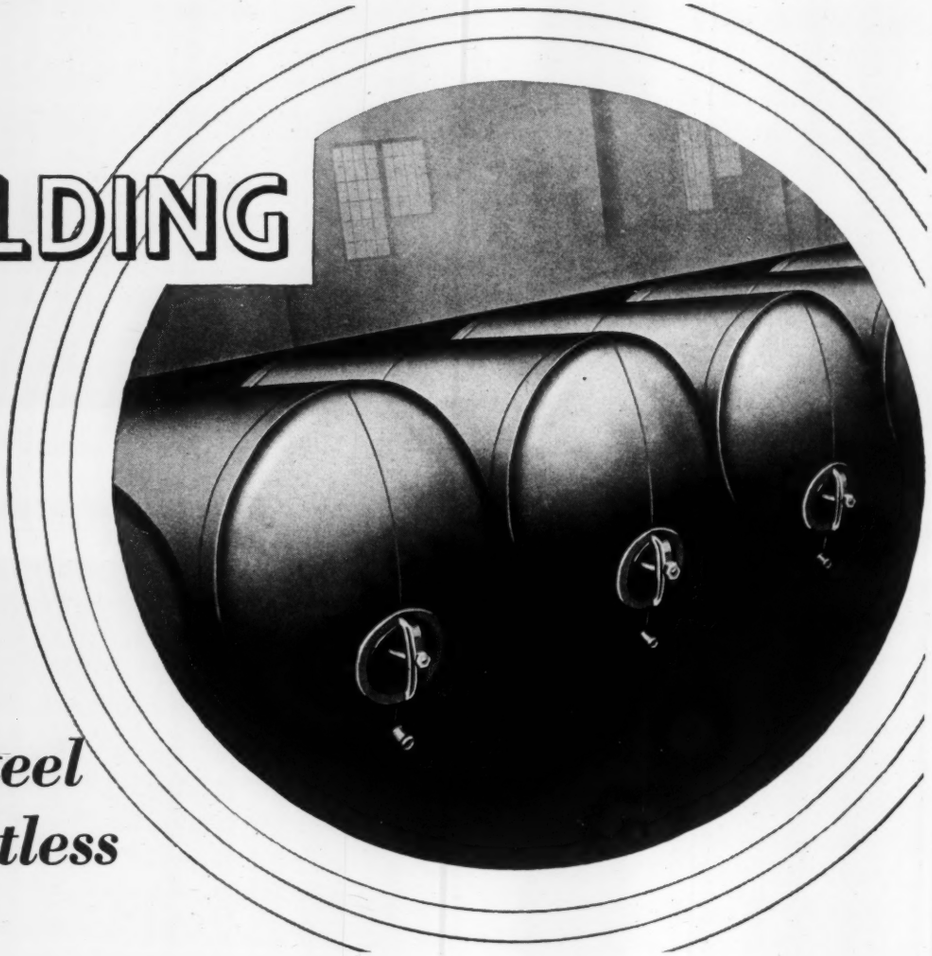
OXWELDING



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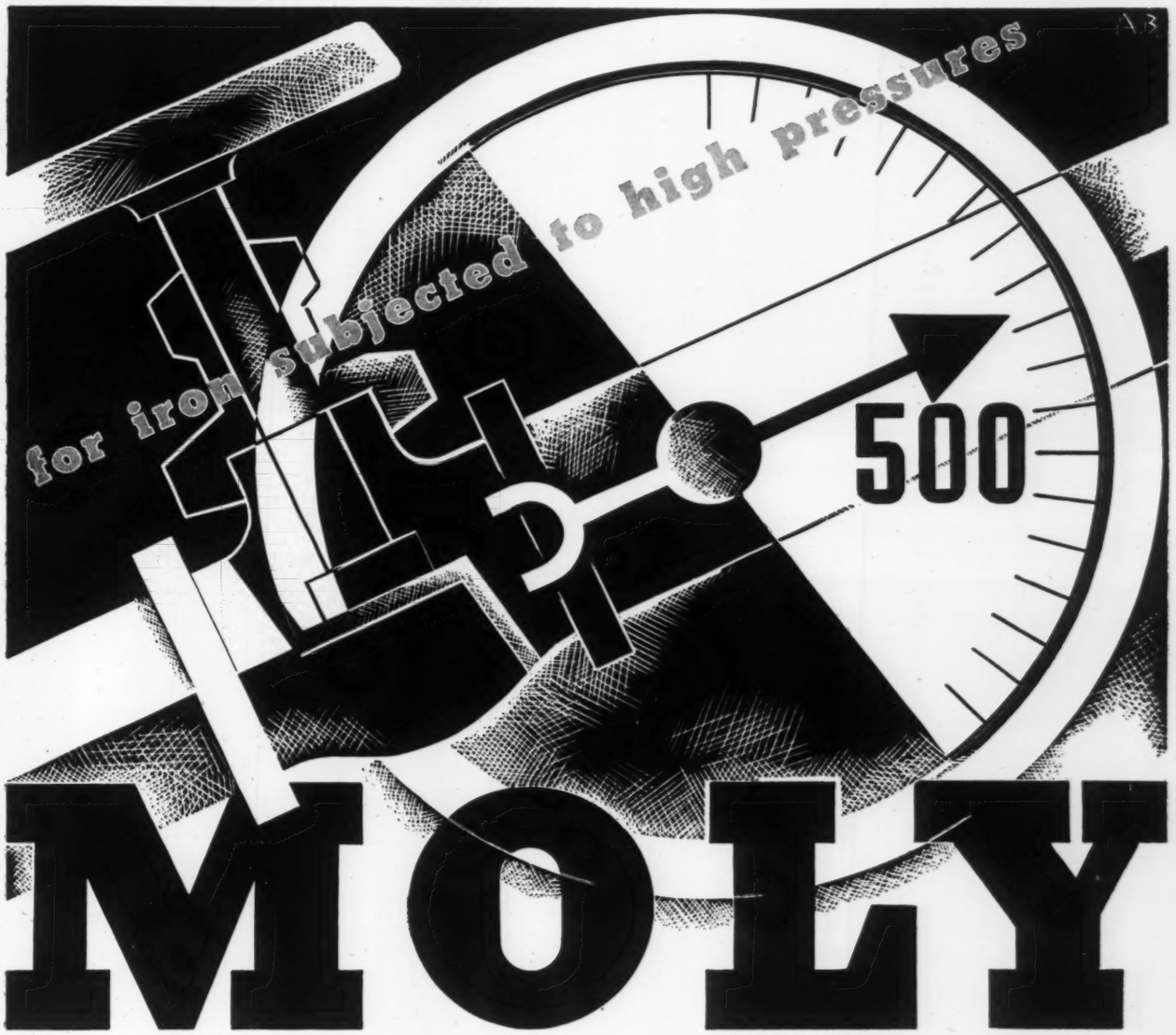

ADVANCING civilization has ever demanded inventions and mechanical improvements to meet its faster economic pace and higher industrial standards. Greater speed — in transportation and in production — has put heavier strains on machinery . . . which in turn, have put higher pressures and other stresses on the irons and steels going into their construction.

For example, more and more is being demanded of such iron castings as Diesel and gasoline engine liners, valves, cylinder blocks, condenser heads, etc. *The most economical and efficient of all methods for meeting the increasingly stringent specifications is by resorting to a Molybdenum-alloyed gray iron.*

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CLIMAX Mo-lyb-den-um

CALENDAR OF MEETINGS AND EXPOSITIONS

THE LARGEST exhibition of machines ever held is scheduled for September . . . It is not too early to start planning to attend * * * At that time, the third National Machine Tool Congress will open in Cleveland . . . . This exhibition, the first since 1929, will occupy every available corner of Cleveland's recently expanded exhibition hall facilities . . . . Neither the vast dairy show nor the transportation equipment exposition approached the size of the machine tool show . . . . Also, neither of these two earlier exhibits contained nearly the percentage of machinery exhibits as will the September exhibition.

For the designer, this exhibition offers a preview of design ideas that have been under development for years . . . . The machine tool industry is one of the most progressive in the field of design . . . . Innovations introduced by this group rapidly find application in other fields * * * Sixty-five per cent of the machines now in use in plants are over ten years old . . . . The machines exhibited at Cleveland will show enormous progress over those already in operation * * * Hydraulic operation, little used in the machines at the last show, will be available in a great many machines . . . . The tendency toward built-in controls will be apparent . . . . Makers of every type of part will have exhibits . . . . Exhibits of particular types of machines, or specific types of parts will be grouped . . . . The designer desiring to inspect some particular type of machine or part will find his task greatly simplified * * * Special rates on the railroads will prevail for this show.

Aug. 19-23—

American Foundrymen's association. Thirty-ninth annual meeting at Royal York hotel, Toronto, Ontario, Canada. C. E. Hoyt, 222 West Adams street, Chicago, is secretary of the association.

Aug. 19-23—

American Chemical society. Semiannual meeting to be held at San Francisco. Charles L. Parsons, 728 Mills building, Washington, is secretary of the society.

August 26-30—

National Association of Power Engineers. Exhibition to be held with the annual convention at William Penn hotel, Pittsburgh. Fred W. Raven, 1140 Lake Street, Oak Park, Ill., is secretary of the association.

Sept. 1—

Exhibit of Metals and Plastics. Permanent exhibition of ferrous and nonferrous metals, plastics, finished and semi-finished parts made from these materials and finishes for metals and plastics will open at International building, Rockefeller Center, New York. Herbert R. Simonds, Metal Products Exhibits Inc., Rockefeller Center, N. Y., is general manager of the exhibit.

Sept. 11-21—

National Machine Tool Exposition. Third exhibition of machines, parts and materials to be held in Public Auditorium, Cleveland, under the auspices of National Machine Tool Builders' association. Roberts Everett Associates, 225 West Thirty-fourth street, New York, are managers of the exposition.

Sept. 11-21—

National Machine Tool Congress. Third congress to be held in Cleveland under the auspices of the Machine Tool Builders' association; Machine Shop Practice division, American Society of Mechanical Engineers; and Production Activity division, Society of Automotive Engineers. Herman H. Lind, 1220 Guarantee-Title building, Cleveland, is general manager of the Machine Tool Builders' association.

Sept. 18-28—

National Electrical and Radio exposition. To be held at Grand Central Palace, New York. Information on the exposition may be obtained from Ralph Neumuller, managing director, Grand Central Palace, New York.

Sept. 24-26—

Association of Iron and Steel Electrical Engineers. Annual convention and exposition to be held at William Penn hotel, Pittsburgh. T. B. Little, Empire building, Pittsburgh, is acting managing director of the association.

Sept. 30-Oct. 4—

National Metal exposition. Seventeenth annual exhibition to be held in International Amphitheater, Chicago. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is general manager of the exposition.

Sept. 30-Oct. 4—

American Welding society. Annual fall meeting to be held at Chicago. M. M. Kelly, 33 Thirty-ninth street, New York, is secretary of the society.

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Differential Analyzer Eliminates Brain Fag

By Irven Travis

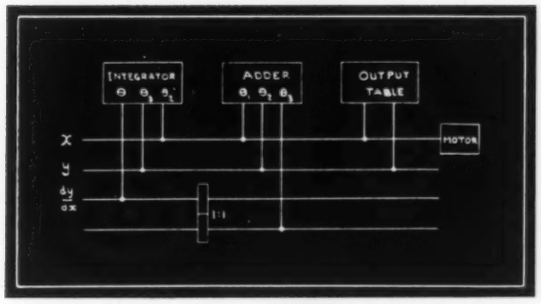


Fig. 1—Schematic arrangement of differential analyzer with one integrator, one adder and an output table

CALCULATING machines for business offices are not the only mechanical units that can perform functions of the human brain. A new machine for solving differential equations has recently been built at the Moore School of Electrical Engineering, University of Pennsylvania. This unique mechanism, *Fig.* 2, is fundamentally the same as the original differential analyzer built under the direction of Dr. Vannevar Bush at the Massachusetts Institute of Technology but differs in appearance and mechanical

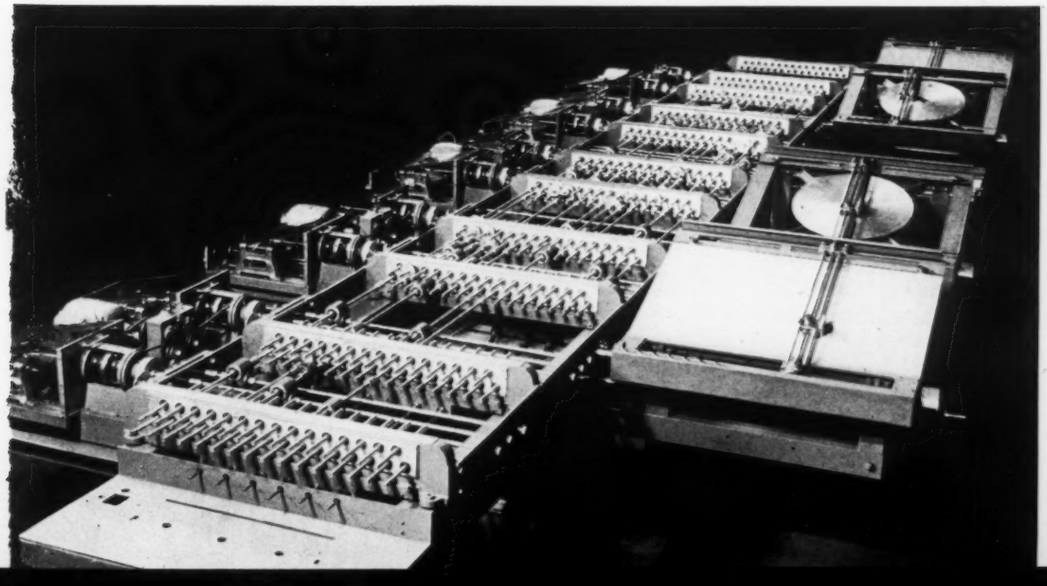


Fig. 2—This machine solves differential equations which otherwise could be integrated only with a prohibitive amount of labor

detail from that machine by virtue of unity of design. The machine built at the latter institution "grew up" over a considerable period of time devoted to research and development. Profiting by the experience and leaning heavily on the advice of Dr. S. H. Caldwell and Mr. L. E. Frost, who were instrumental in designing the original machine, the design group at the Moore school has produced an analyzer which it is anticipated will represent a step forward in ease of operation and numerical accuracy.

Design and construction of the Moore school device was carried out as an emergency relief project. The organization grew from a nucleus of a half-dozen in January, 1934, when the project was started, to about one hundred and

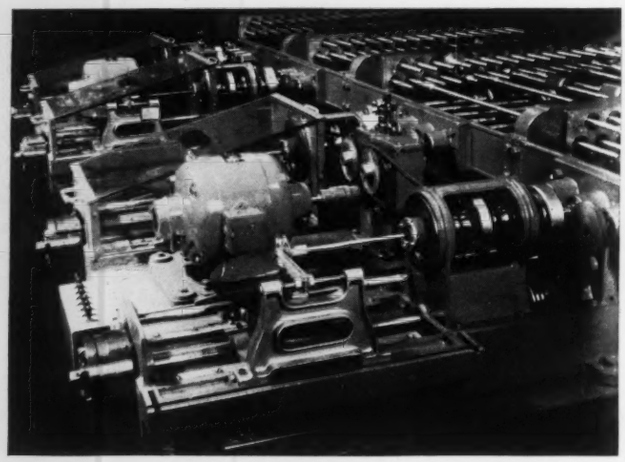


Fig. 3—Close-up of integrator unit shows the various mechanisms embodied in the unique design

twenty men at the peak of production. Finishing touches are now being added by a small group of engineers and toolmakers.

Design Time Was Limited

In the redesign of the analyzer, particular attention was given to accuracy, ease of operation, cost of manufacture and appearance. Manufacture followed closely on the heels of design so that it was not possible to make radical changes without a considerable loss of time and material. Makeshifts were therefore resorted to in some cases. Since it was the purpose of the Civil Works Administration and related agencies to provide employment, a project was considered more desirable when the ratio of labor cost to material cost was high. In order to fulfill this aim many details of design were chosen in such a way that as many parts as possible could be made in the shop instead of being purchased. In numerous cases the actual cost of manufacture would have been less had some standard product been specified.

Although the machine can be used for simple integration and for harmonic analysis, its real value lies in its ability to solve, in a comparatively short time with sufficient accuracy for engineering purposes, differential equations which could otherwise be integrated only with a prohibitive amount of labor.

Operating Principle Explained

In order to separate the principle of operation of the equipment as a differential equation solver from the complications of its mechanical design let it be assumed that it provides means for performing the algebraic operations (addition, subtraction, multiplication and division) and a device which integrates. Each of these devices is mechanical in nature and each represents the quantities with which it deals by angular displacements of shafts. If the angular displacements of these shafts (each from some arbitrary datum) be designated by θ_1, θ_2 and θ_3, then the *adder* nature of the device for adding is described by the equation

$$\theta_1+\theta_2=\theta_3 \qquad (1)$$

In a similar manner the following equations:

$$\theta_1\times\theta_2=\theta_3 \qquad (2)$$

$$\theta_3=\int\theta_1\,d\theta_2 \qquad (3)$$

describe the multiplier and integrator respectively. Inverse operations of subtraction or division may be obtained simply by operating the adder or multiplier backwards.

For simplicity a differential analyzer having one integrator and one adder will be considered. A schematic arrangement is shown in *Fig.* 1. The element indicated in this figure as an output table consists of an arrangement of two lead screws at right angles, which drive a pencil in such a way as to plot the result in rectangular co-ordinates. Such an analyzer is capable of solving, for example, the equation

$$\frac{dy}{dx}+x+y=0 \qquad (4)$$

Let three shafts be mounted in bearings so that they are free to rotate and let them be labeled arbitrarily y, x and dy/dx. If these three shafts are coupled to the shafts denoted by θ_3, θ_2 and θ_1 of an integrator in the order written the proper integral relation is insured. If, also, x and y are coupled to θ_1 and θ_2 of an adder and θ_3 coupled through a pair of one to one gears to reverse the directions of rotation, to dy/dx, the condition stated by (4) is insured. If now the shaft x be driven by a motor the whole mechanism must move in such a way that the angle turned through by the shaft y corresponds to the integral of the given equation. Boundary

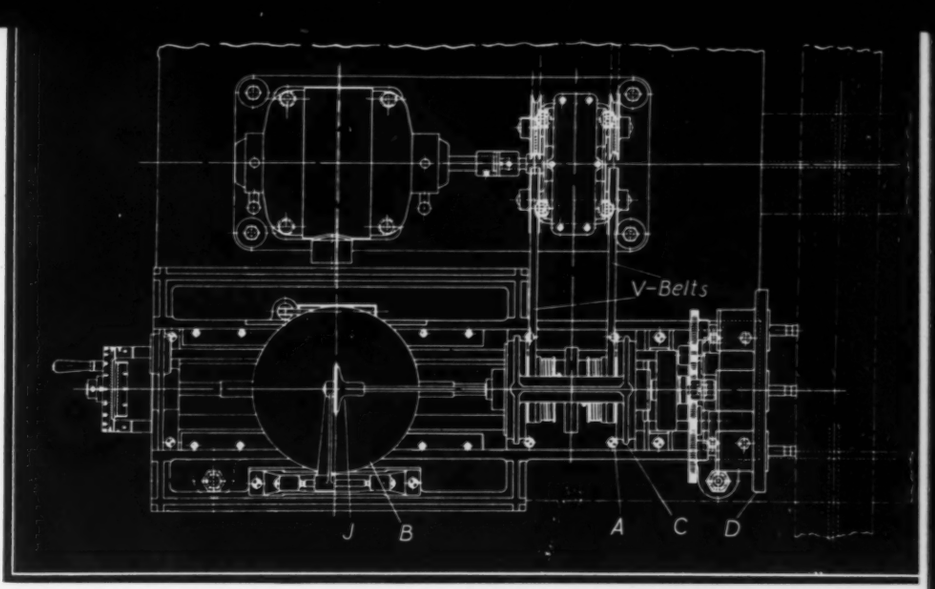


Fig. 4—Because it is necessary for the integrator input wheel to contact the carriage disk at all times, alignment of bearings must be perfect. This is accomplished by grooves in the machine bed

conditions are imposed by the initial displacement of the various shafts.

Addition is accomplished by an ordinary differential which need not be described here. The device for multiplication has inherent errors and is not very satisfactory. Since its use can usually be avoded by proper transformations in the differential equation to be solved it is of only secondary importance.

Antifriction Bearings for Low Speeds

To hold friction to a minimum, particularly on those shafts which rotate at comparatively low speeds, ball bearings were used almost throughout. It had been found previously by experience with the M.I.T. machine that static friction and friction at very low speeds were limiting factors. Due to the fact that the output of the torque amplifiers is limited to about one and one-half pound feet for stable operation, it is extremely important to keep the total friction load as small as possible. This reduction of friction in all shafting provides a margin which can be used in increasing the accuracy of lead screw drives by providing a much tighter fit of the lead screw nuts on the lead screws.

In the design of the integrator unit, *Fig.* 3, grooves in the base of the machine automatically maintain alignment of all bearings and shafts. Referring to *Fig.* 4, it will be seen that front bearing *A*, integrator carriage *B*, the torque amplifier housing *C*, the magnetic clutch bearing and the back bearing *D* all must be in alignment and that the torque amplifier input shaft must be parallel with the lead screw so that the point of contact of the integrator output wheel with the integrator disk always is on a diameter of the disk.

The same method of grooves was employed to align the main bearings of the torque amplifier *E* and *F*, the bearings for the torque amplifier drums *G*, the torque tube *H* and the outboard bearing *V* for the input shaft, *Fig.* 5.

Another place in the machine where alignment is of extreme importance was in the main bus shaft housings. Each of these housings has thirty-one holes through the two sides, every hole carrying a shaft mounted in two ball bearings. Holes are arranged in two rows, one having sixteen holes and one having fifteen holes and the center distances are held constant so as to allow complete interchangeability of gears. There are eleven of these housings spaced approximately two and one-half feet apart which must be aligned so that if all thirty-one shafts were to be coupled straight through, the friction on each coupled shaft would only be approximately eleven times the friction of one shaft.

Jack-Screw Obviates Shimming

In order to avoid shimming, a jack-screw arrangement was employed to insure alignment. Taper dowel pins are used to prevent mishandling by future operators.

To reduce moment of inertia an inverted type of magnetic clutch, in which the rotating parts

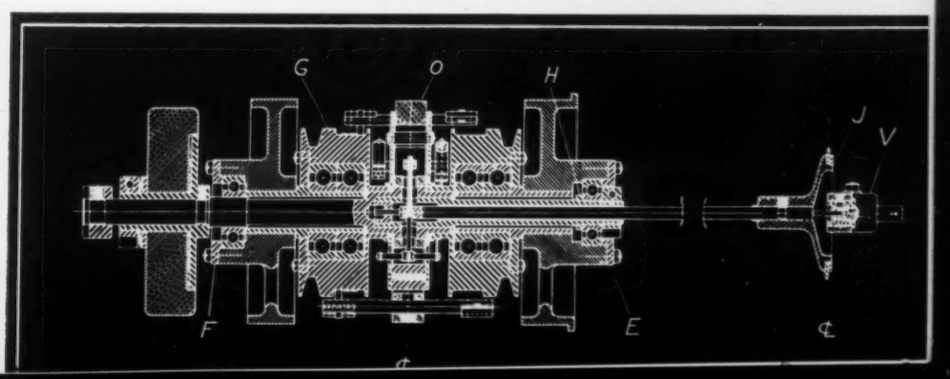


Fig. 5—Stainless steel tire on input wheel J provides good traction on carriage disk (see drawing above) which is of Nitralloy

are light in weight, was developed. The solenoid itself, which must necessarily be heavy, is stationary, the rotating parts consisting only of a spring, thrust collar, aluminum cone clutch plate and a steel gear which serves the dual purpose of gear and movable clutch plate. Throughout the rotating structure of the friction drive to the torque amplifier, aluminum was used whenever possible.

Loss of angle due to slippage can occur only in the friction drive of the torque amplifier, *O, Fig.* 5, in the magnetic clutch of the integrator

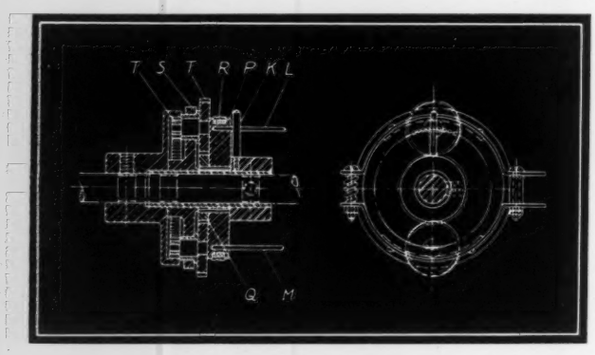


Fig. 6—Front-lash unit incorporates a device for correcting residual backlash

or due to slipping of gear and coupling set screws. Practically all gears and couplings are removable and must be set up for each new problem. The time required for this would be greatly increased if keys were used. Cup point set screws are employed, slight undercuts being provided at set screw locations to clear burrs. Reduction of friction throughout the machine decreases the likelihood of slippage. New materials were utilized for the torque amplifier friction drive to reduce this hazard. Stainless steel tires are used on the integrator input wheel *J, Figs.* 4 and 5, and the integrator carriage disk *B, Fig.* 4, is made of Nitralloy. This provides good traction as well as insuring an extremely smooth and wear-resisting surface on the carriage disk.

Clever Idea Corrects Backlash

Backlash is corrected by means of a so-called "front lash" unit which is especially interesting. Referring to *Fig.* 6, it will be observed that when the pin *K* is in contact with either pin *L* or *M*, and driving toward that pin, the friction drum *P* is caused to slip inside the brake *R*. Plate *S* is pinned to the right-hand or input shaft and the inner gear *Q* is pinned to the friction drum; hence the planetary gears *T* cannot rotate about their own axes and the device acts as an ordinary coupling. When reversal of direction of rotation of the input shaft occurs pin *K* moves away from pin *L* or *M* against which it is driving. The friction of the brake *R* is great enough to hold the drum and gear *Q* fixed so that the shaft to the left is driven through the planetary gears at a speed slightly in excess of the speed of the shaft to the right. During this interval the angle turned through by the output shaft is greater than the angle turned through by the input shaft. Inasmuch as the distance between *L* and *M* is adjustable this gain in angle can be varied at will. It, therefore, can be made equal to the loss in angle occuring in a gear train, thus correcting all residual backlash and increasing the accuracy of the machine.

Design of the machine throughout was made generous as regards size of all parts so as to reduce the possibility of deformation. As a result many of the parts may seem abnormally large. This has a further advantage in ease of operation, accessibility and maintenance of the equipment.

Parts Balanced to Combat Vibration

Some attention was given to the obviation of vibration of the machine as a whole due to traffic passing the building. It was found, however, that the 10-inch concrete floor on which the unit is located suffered inappreciable vibration from such causes. Feet of the machine supports are, therefore, bolted rigidly to this floor and grouted to it by means of sulphur. The input shaft to the torque amplifier and the torque amplifier output-input arm were both balanced statically and approximately balanced dynamically so as to reduce vibration in these parts. The only other source of vibration of any account is the torque amplifier, itself. This offered a serious problem which has not yet been satisfactorily solved.

The torque amplifier *O, Fig.* 5, has a tendency to oscillate due to the minor variation in amplification and possibly due to some feed back through the torque amplifier frame. Use of an inertia damper greatly improves the operation, but even with the damper slight maladjustments of the amplifier brake bands may cause severe vibration.

Elimination of errors due to thermal expansion of shafts, of which the length from a given point is important, was effected by positively locating such shafts at the given point by means of preloaded ball bearings, leaving the other ends floating. This applies to all lead screws and to the torque amplifier input shaft. The permitted error in machining of the lead screws is of the same order as the error introduced in them due to expansion over a normal temperature range. Another place in which expansion is important is in the torque amplifier drums. These drums have a temperature rise under load of about 50 degrees Cent. so that a special ball bearing fit is necessary.

SCANNING THE FIELD FOR IDEAS

PLASTICS SOLVE ANOTHER PROBLEM

WHAT Frank J. Cannon, Production Instrument Co., has to say about molded plastics and why they are used in the design of high speed counters, *Fig.* 1, speaks well for the increased use of this material. "Solution of our problem was found several years ago in the use of Bakelite molded number wheels, this particular material being selected because of its durability, ruggedness and light weight.

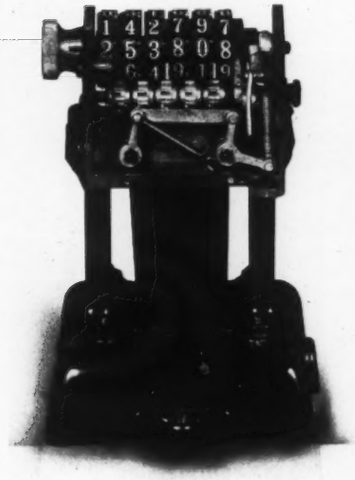


Fig. 1—In gruelling test on counters of this type, Bakelite number wheels have proved their ability to stand up under conditions that demand a durable, rugged and light weight material

"From time to time we have carried on careful speed tests to determine the wearing qualities of molded plastics over various other materials, at designated speeds. It has been found that, in every instance, the molded plastics are much more desirable. At the present time we are conducting a breakdown test in which a mechanical counter and an electrical counter both are equipped with molded plastic wheels. The instruments, running at a speed of 516 per minute, had attained a total registration (April 1) of 49,186,740 with an error of only 2 between each counter.

"Ratchet teeth on both counters are in excellent condition, showing little or no wear, and are easily capable of 50,000,000 more impulses. Several years of experimenting on molded ratcheting devices indicates to me the vast possibilities manufacturers will find in molded units. All counter equipment being built by this company now, and for several years previous, are equipped with Bakelite molded numeral wheels and molded bases."

SCREW "WEIGHS" GRANULAR MATERIAL

VIRTUALLY a glance at the illustration of a coal meter, *Fig.* 2, reveals a simple but interesting idea employing the principle of the screw. Weight of crushed coal or any other granular material for that matter may be measured by this mechanism. As coal passes down the spout it causes the vane to turn a definite amount with each foot of travel. This motion is transferred through a flexible shaft to the counter which indicates the weight of the material in hundreds of pounds.

Since the meter in reality gives a volume measurement, accuracy of the readings on a weight basis will of course depend entirely upon the uniformity of the weight per cubic foot of the material passing through the pipe around the vane. Bailey Meter Co., Cleveland, manufactures the device.

Fig. 2—As spiral vane is turned by crushed material passing down pipe, its motion is transferred to a recorder by a flexible shaft, thus indicating the weight of the material in hundreds of pounds

AIR CURTAIN SERVES AS DOOR

UTILIZING a curtain of air for a kitchen door may appeal to housewives more than engineers but it nevertheless embodies an idea. This invisible door, always shut, is employed in the new Burlington Zephyr streamlined train be-

tween the kitchen and the eating space in the dining car. It offers unobstructed vision and free passage at all times, but keeps cooking odors and heat away from the passengers being served. A sheet of air is forced through a small slit in both sides of the doorway frame, directed toward the center and deflected slightly toward the kitchen. Immediately overhead on the kitchen side is an exhaust ventilator which picks up the fumes checked by the moving air curtain, and carries them outside of the car.

FUEL FOR ENGINE COOLS TRUCK

RADICAL improvements in the Mc-Cord refrigeration-fuel system for trucks, present a striking case of redesign for space economy and lowered installation costs. This idea, discussed briefly on page 21, Dec. 1934, MACHINE DESIGN, involves the use of Petrogas (propane), first as a refrigerant for the truck body and then as fuel for the engine. In the earlier system various elements such as the evaporator, heat exchanger, expansion valves, etc., were separated and located both inside and outside the truck body. Now they are combined in a compact tubular convector, *Fig.* 3, right.

The liquid propane, carried in cylinders under the truck, *Fig.* 3, left, is led by its own vapor pressure through tube *A* of the heat exchanger *F* where atmospheric heat of the liquid is removed. Subsequently, it passes through expansion valve *B*, from which it issues into tube *C* of the evaporator or cooling unit as a saturated gas and at a pressure of approximately five pounds.

In its conversion to a dry gas, heat absorption is effected, and the surface of both tube and fin of the cooling unit are reduced to a low temperature. Air drawn from the interior of the truck body passes through openings in the sides and bottom of the outer sheathing and then over the surface of the spirally wound low temperature coils located in the annular space between outer and inner casings. Through this "chimney" it is drawn upwards and recirculated by the motor-driven fan *L* through the cold air duct *O*.

Dry gas then is led from the evaporator through tube *D* to the top of the heat exchanger where in its spiral descent, it absorbs the atmospheric heat of the incoming liquid as mentioned earlier, passing outward through tube *J* to the regulating and mixing valves *S*, *T* and *V*, and thence to the motor. During the loading period or a night stop-over when the motor is not in operation, circuit *HMK* permits circulation of any cooling medium.

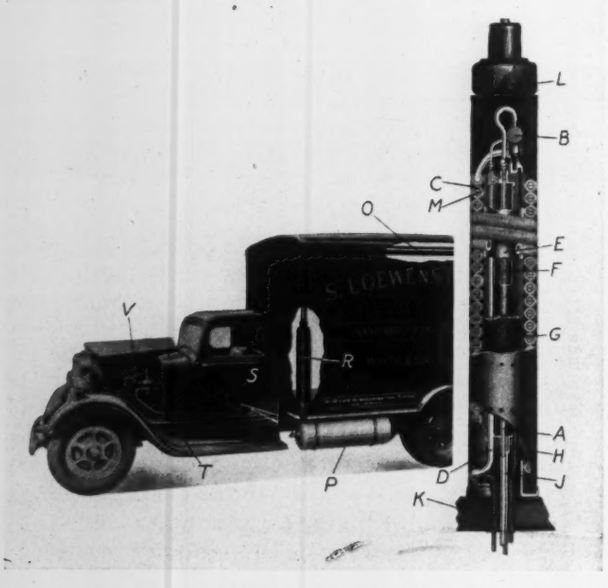


Fig. 3—*Refrigeration-fuel system using propane has been redesigned as compact unit that fits into corner of truck*

DRIVING BY COMPRESSED AIR

EUROPEAN engineers are not overlooking the possibilities of compressed air as motive force. In Germany a compressed air roll motor, *Fig.* 4, has been designed for driving belt conveyors, winches and hoists. According to *Engineering Progress* several sizes of this machine, ranging from 10 to 125 horsepower, are in use.

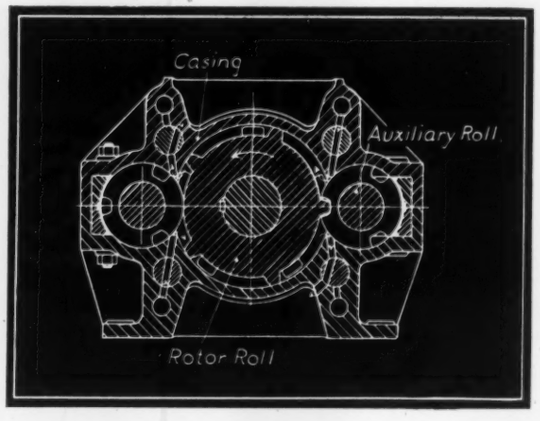


Fig. 4—*Drive is effected as compressed air strikes rotor teeth which engage grooves in auxiliary rolls*

Along the periphery of the main or rotor roll are a number of teeth which function in the manner of pistons or plungers and engage corresponding grooves in the contacting auxiliary rolls. Air is admitted and discharged through valves that may be used to reverse the direction of rotation of the machine. A centrifugal governor prevents the motor from attaining excessive speed when the load is suddenly released.

In operation air enters through the inlet passages into the working chamber where it strikes one of the teeth of the rotor. Motion thus is effected and as the next tooth emerges from the groove in the auxiliary roll it comes into con-

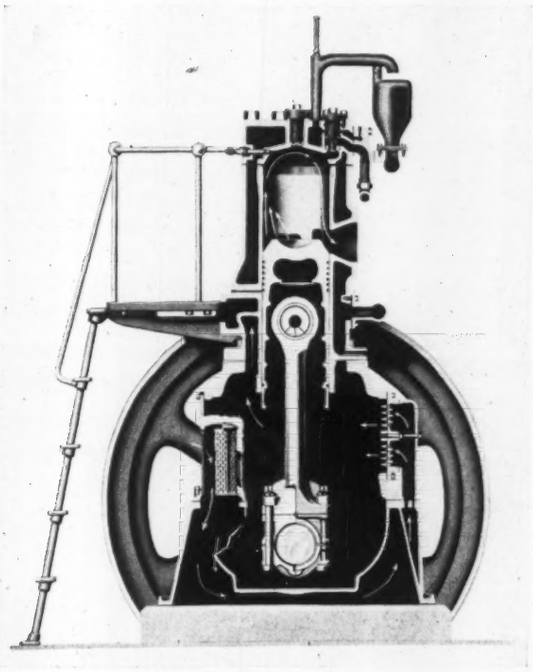


Fig. 5—Automatic scavenging is attained in this diesel by utilizing the pumping action of piston

tact with the air stream. Air commences to escape as soon as the first tooth exposes the outlet port. The cycle described applies to operation at constant pressure, and takes place, also on the lower side of the rotor, constituting a double acting arrangement.

PISTON SERVES AS PUMP

MOVEMENT of the piston in the crankcase provides the necessary pumping action to supply air for scavenging and combustion in this automatic scavenging Diesel engine, thus eliminating those extra parts otherwise required for separate scavenging. On the upward stroke of the piston, air is drawn through a screen and automatic valve into the crankcase and is there compressed, on the working or down stroke of the piston, to a pressure of a few pounds. As soon as the piston has uncovered the air ports in the cylinder, near the end of the down stroke, this air rushes into the cylinder and effects complete scavenging of the burnt gases.

Cored passages for conducting the scavenging air from the crankcase to the cylinder are so arranged that the air enters the cylinder directed tangentially toward the wall opposite the exhaust ports. As indicated in *Fig.* 5, the air flows upward in a column of constricted cross section along this wall, makes a clean sweep across the cylinder head and down the opposite side pushing the exhaust gases out and leaving no pockets in which burnt gases can remain.

This arrangement of ports and passages has effected a reduction in fuel consumption in this engine, built by Fairbanks, Morse & Co., to 0.38 pounds per horsepower hour on the 14 by 17-inch cylinder size and to below 0.40 pounds on the smaller 12 by 15-inch engines.

MORE BEARING SURFACE—LESS WEAR

BY EMPLOYING a long sleeve midway of the axle, a solution has been found for the maintenance problems caused by the conventional loose wheel on rail motor cars. This innovation, *Fig.* 6, provides a bearing area three times larger, on a leverage over five times as long, reducing bearing pressure per inch to about one-fifteenth of that which prevails in the loose wheel bushing.

The axle is designed on the principle of the differential, one per car being installed on the end opposite the drive axle. In taking curves in the track the outer wheel is free to turn more than the inner one, inasmuch as the axle is divided into halves coupled together. A two-piece bronze center connection bolted inside the steel axle sleeve prevents end play. In addition to reduced maintenance costs, possibility of accidents caused by wobbling or undergage loose wheels is obviated.

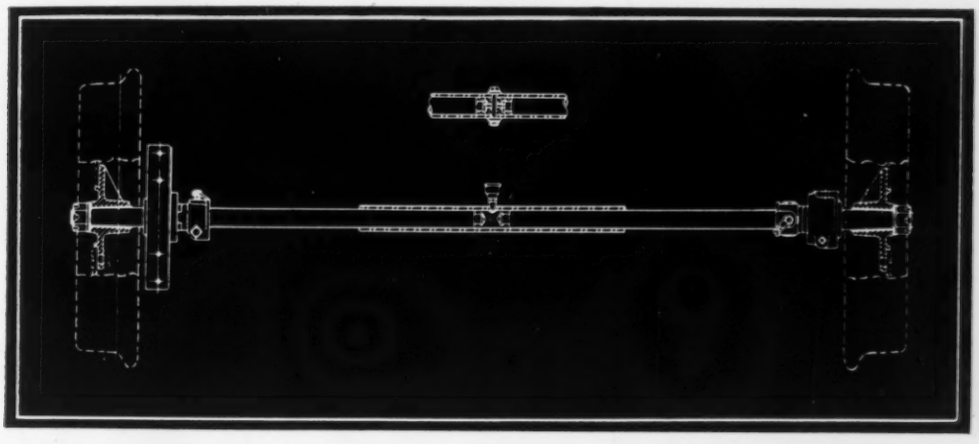


Fig. 6—Substituting a long sleeve midway of the axle for the conventional loose wheels, this idea provides a bearing area three times larger than that of the loose wheel bushing

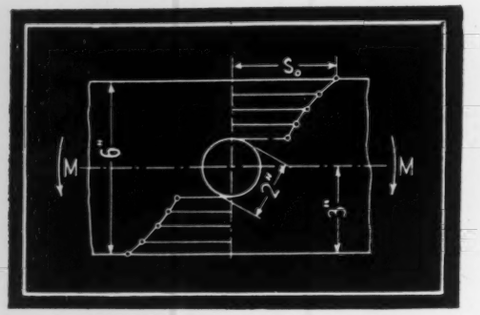


Fig. 8—A hole with its axis located in the neutral plane of a beam does not affect its strength materially

Second of a Four-Part Series

Avoid Waste of Material in

By V. L. Maleev

Professor of Mechanical Engineering, Oklahoma Agricultural and Mechanical College

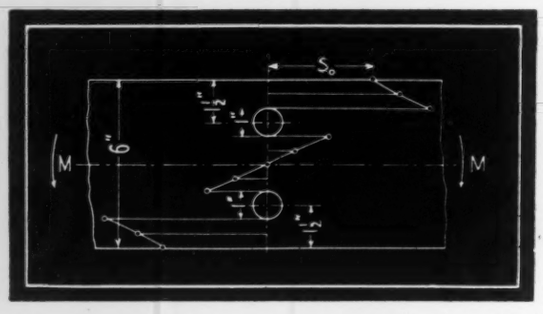


Fig. 9—Holes located halfway between neutral plane and edge of beam show maximum stresses about 1.5 as great as outer fibers

DISCONTINUITIES in bending and discontinuities in torsion are two of the most important factors in the consideration of stresses. The new approach to design introduced on page 15 of the June issue of MACHINE DESIGN allows the designer to obtain greater safety with smaller safety factors and often with smaller weights.

The influence of holes upon the stresses in a bar subjected to bending may be found by superimposing the hole-concentration stresses, such as shown in *Fig.* 1 (M. D., June, p. 15) on the bending stresses. A hole with its axis located in the neutral plane of a beam, *Fig.* 8, practically does not affect its strength. A hole located nearer to the beam edge may result in high stresses at the hole edge, exceeding those in the outer fibers of the beam. Thus, holes located halfway between the neutral plane and the edge of a beam show maximum stresses about 1.5 as great as at the outer fibers, *Fig.* 9.

Fig. 11 gives values of the theoretical form factor for notches as found experimentally[10] for bending. The curves of r = const have a parabolic shape and those of h = const have a hyperbolic shape and with the decrease of r, sharper notches, the values of k increase very fast, approaching the limit values. The values from *Fig.* 11 can be used with a sufficient accuracy also for tension and compression.

Fig. 10 gives the data relative to depth h, radius r, and width b of notched bars in bending and *Fig.* 13 shows the stress distribution and the distance along the axis upon which a sharp notch extends its influence.

The form factor k in bending for fillets of symmetrical sections, as those shown in *Fig.* 7, (M. D., June, p. 18) is usually assumed to have the same values as that in tension. Latest experimental data[9] seem to show that k in pure flexure is about 20 per cent lower than in tension.

[9]Weibel, E. E., *Trans. A.S.M.E.*, 1934, APM-56-13, p. 641.
[10]*Zeitschr. d. Ver. deutsch. Ing.*, 1923, p. 375.

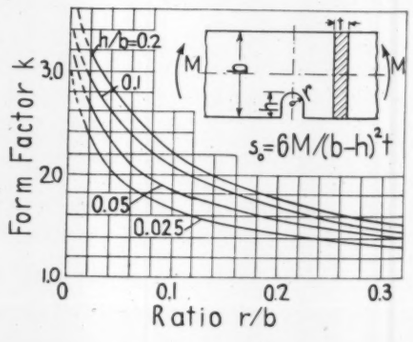


Fig. 10—Form factor relative to depth, radius and width of notched bars in bending

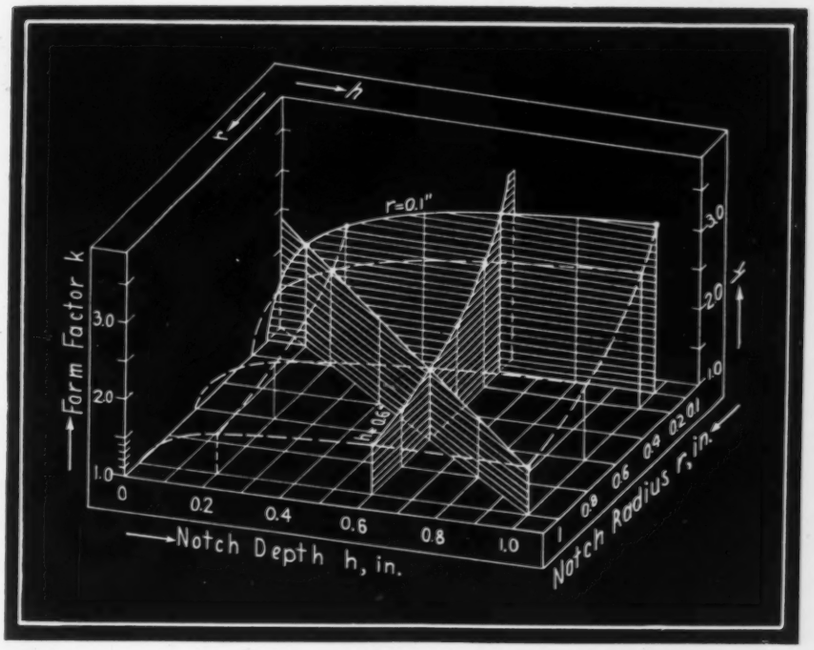


Fig. 11—Values of theoretical form factor for notches as found experimentally for bending

Parts Design!

The factor k is practically the same for flat sections, such as ribs, and for junctures of shafts of different diameters.

The influence of an one-sided fillet as in an angle-shaped section is represented in *Fig.* 12, which gives values of k found by photoelastic measurements[11].

The form factor for the highest stressed fiber of an angle-shaped section with the thickness ratio $b/h = 4$ is given in *Fig.* 14 as a function of the fillet-radius ratio r/h and the distance l of the bending force application. It shows that for $r = 0$ the factor $k = 6$.

Discontinuities and Torsion With Shafts

With a torsional shear the form factor generally is smaller than with direct stresses or flexure. If the cross sections of a straight shaft are circular but vary in diameter, a plane section remains plane after twisting but a diameter does not remain straight after twisting. The change in the diameter results in a concentrated shear stress as illustrated in the upper corner of *Fig.* 15. The form factor is a function both of the ratio of the two adjacent diameters and of the relative size of the fillet. Its values can be taken from curves of *Fig.* 15.

Keyways have a stress concentration effect which is noticeable particularly at the end of the keyway. So far very few numerical values are available. *Fig.* 17 shows the relation between the form-factor k in torsion and the size of the fillet r in the keyway corner referred to the width b, as determined by the soap-film method[12]. Numerically k is very high and the rectangular keyway should be avoided in high stressed shafts. The influence of the keyway extends down to the inner edge of the hollow shaft.

[11] *Z. V. d. Ing.*, 1932, p. 507.

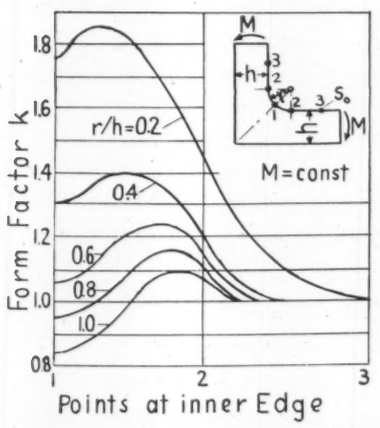


Fig. 12—Influence of a one-sided fillet as in an angle-shaped section in bending

Depend on Structure of Materials

While theoretically form factors do not depend upon the material, tests show that actual *stress concentration factors* k' depend upon the structure of materials and, with static loading, are considerably smaller than the corresponding form factor k.

The relation between k' and k can be expressed as

$$k' = 1 + q(k-1) \quad \ldots\ldots (8)$$

where q may be termed the *index of sensitivity* of the material to abrupt changes of section. From equation (8).

$$q = (k'-1)/(k-1) \quad \ldots\ldots (9)$$

Tests with various materials have shown that

[12] Seely, F. B., *Adv. Mech.*, p. 228.

q depends upon the ductility or brittleness of the material and also upon the type of loading.

Significant stress can be presented now as

$$s_{sg} = k' s_n \quad \text{.....(10)}$$

Outlines Design Calculations

The equation of stresses used in the conventional design are based on the assumption of equilibrium between external forces and internal stresses. These equations can give correct values for the stresses in machine parts only for cases of static loading.

In most cases, in order to determine the true actual stresses in various sections, additional factors must be taken into account. These factors are: (a) type of load; (b) the maximum and also the minimum values for varying loads; (c) method of application and rate per unit of time for repeated loads; (d) discontinuities; (e) certain properties of the material, other than determined by static tests; and (f) internal stresses set up by manufacturing or operating conditions.

The actual stresses in a certain section are seldom uniform and the determination of the maximum stress and of the point of its action is of the greatest importance.

Types of Loads Distinguished

Three main types of loads must be distinguished as: 1—Steady loads, called static or dead loads; 2—Impact or shock loads; and 3—Repeated loads which cause variable stresses. The latter may vary in their intensity only or may be caused by repeated impact loads.

The designing of parts subjected to different types of loading differs very much one from another and must be considered separately.

STATIC LOAD—This is the simplest case. The elementary equations apply almost without correction. The main influence to be considered is the size factor e_{sz}. The design is based upon the magnitude of the elastic limit S_e. If the proportional elastic limit S_e is not known for a certain material, the yield point S_y may be used instead.

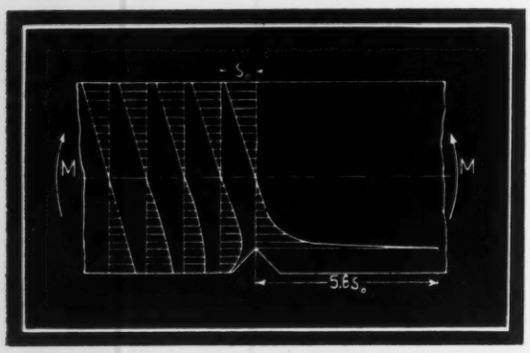


Fig. 13—Stress distribution and the distance along the axis upon which a sharp notch extends its influence

Stress concentration is small with static loading, due to the elasticity and plasticity of the materials. Their molecules can readjust themselves and produce a more or less uniform stress distribution. Thus, for ductile materials $q = 0$, $k' = 1$ and from expression (10) $s_{sg} = s_n$, the discontinuity does not affect the significant stress. For brittle materials, such as a hardened steel, it may be taken $q = 0.1$; for very brittle ones, such as steel quenched but not drawn, $q = 0.25$. Cast iron, due to its structure with many internal discontinuities, has $q = 0$, the same as ductile metals.

Design stress can be presented now by the expression

$$S_d = S_e'/f = e_{sz} S_e/f \quad \text{.....(11)}$$

The nominal safety factor should not be taken less than 1.25, better 1.5. If the quality of the material is not of the very best or if there is no definite information to this effect, it is advisable to use $f = 2$. If the yield point S_y is used instead of S_e, the safety factor should be increased by about 25 per cent.

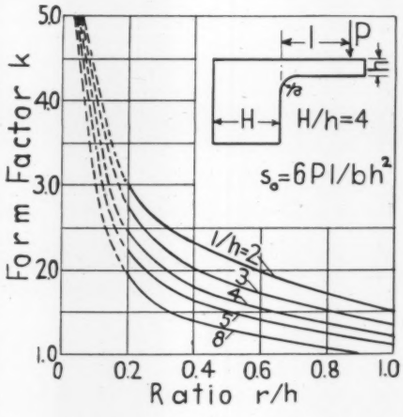


Fig. 14—Form factor for the highest stressed fiber of an angle-shaped section in bending

The actual safety factor

$$f' = S_d/s_{sg} = e_{sz} S_e/k' s_n \quad \text{.....(12)}$$

Determining Impact Loads

IMPACT LOADS—The design of a part subjected to impact is conducted along the same lines as of that loaded statically with two differences only: The significant static stress is increased by the impact; and the index of sensitivity q is also increased. The magnitude s' of the impact stress can be determined by the equation[13]

$$s' = s[1 + \sqrt{1 + (2h/e)}] \quad \text{.....(13)}$$

where s is the stress produced by the striking body if it were acting as a static load, h is the impact travel and e the deformation corresponding to the same stress s.

[13] *Marks' Handbook*, p. 429.

Determining s from expression (13) gives for the allowable nominal stress

$$s = s'/[1 + \sqrt{1 + (2h/e)}] \quad \text{.....(14)}$$

or for the more common case of tension

$$s' = s[1 + \sqrt{1 + (2hE/ls)}] \quad \text{.....(15)}$$

and

$$s = (s')^2/2[(hE/l) + s'] \quad \text{.....(16)}$$

where E is the modulus of elasticity, and l the length of the member subjected to impact.

The dimensions of a part which is designed to take an impact are found using in expressions (14) or (16) the allowable design stress S_d in place of s'.

For ductile materials, depending upon the degree of ductility, the *index of sensitivity*, q, should be taken from 0.4 for very soft and ductile up to 0.6 for less ductile materials. For hard and brittle materials, as hardened steel, q should be taken as 1, making $k' = k$. However, cast iron can be classified among the less sensitive materials with q about 0.5.

Resilience is the measure of the capacity of a body to resist impact. The general expression for the resilience U may be presented as

$$U = 0.5\,Pe \quad \text{.....(17)}$$

where P is the load and e is the deformation produced by it.

For a tensile load, substituting $P = As$ and

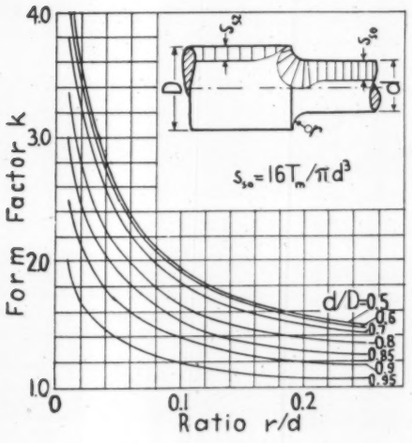


Fig. 15—A change in diameter results in a concentrated shear stress with bar in torsion

$e = sl/E$, expression (17) becomes

$$U = 0.5\,As \times sl/E = S^2V/2E \quad \text{.....(18)}$$

where V is the volume of the member in cubic inches.

Modulus of resilience is found from expression (18) with $s = S_e$, and $V = 1$ cubic inch.

$$U = S_e^2/2E \quad \text{.....(19)}$$

Moduli of resilience for other types of loading can be found in handbooks[14].

It should be noted that in the case of impact the stress in expression (18) is the impact stress s', expression (13) or (15).

After a part is designed for impact loading, its proportions must be carefully checked to make sure that its resilience U is sufficiently greater than the impact energy K_i. U may be determined by the general expression (17) or by a special expression, depending upon the type of loading, such as expression (18) using S_e', expression (4), (M. D., June, p. 17) for the stress. The impact energy may be determined from the expression

$$K_i = W(h + e') \quad \text{.....(20)}$$

where W is the weight of the striking body, h the impact travel, and e' the deformation of the member.

Since the energies are proportional to the square of the stresses, therefore the safety factor f' in terms of stresses is

$$f' = \sqrt{U/K_i} \quad \text{.....(21)}$$

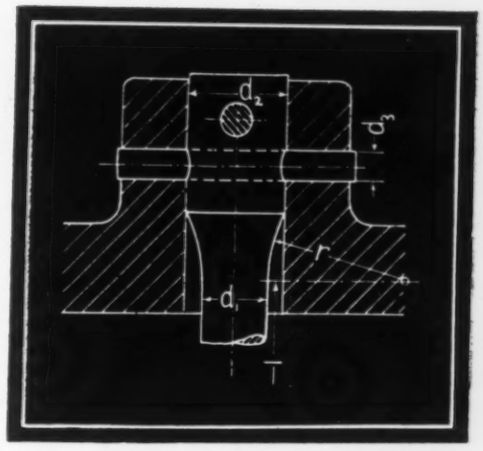


Fig. 16—Typical fastening of a rod end

EXAMPLE 2.—Determine the main dimensions of a round SAE 1030 steel rod stressed in tension by a weight of 200 pounds falling from a height of 2 inches; the free length of the rod is 60 inches; the ends of the rod are fastened as shown in *Fig.* 16.

In the preliminary calculations S_e' can be assumed as $0.95S_e$ or $0.95 \times 42{,}000 = 39{,}900$ pounds per square inch and the design stress, with $f = 2$,

$$S_d = 39{,}900/2 = 19{,}950 \text{ psi}$$

The significant stress is found by expression (16)

$$s = 19{,}950^2/[2(2 \times 30{,}000{,}000/60) + 19{,}950] = 195 \text{ psi}$$

The necessary cross-sectional area

$$A = P/s = 200/195 = 1.026 \text{ sq. in.}$$

and the diameter

$$d_1 = \sqrt{1.026/0.7854} = 1.144 \text{ in.}$$

For static loading the actual dimension used would be the next larger one or 1-3/16 inches. For dynamic loading, in order not to decrease the deformation, it is better to round the figure *down* to 1⅛ inches.

At the ends the diameter must be increased to take care of the weakening by the cross-pin

(*Continued on Page* 68)

[14] *Marks' Handbook*, p. 417.

Utilizing Hydraulics for Indexing

By Harold B. Veith

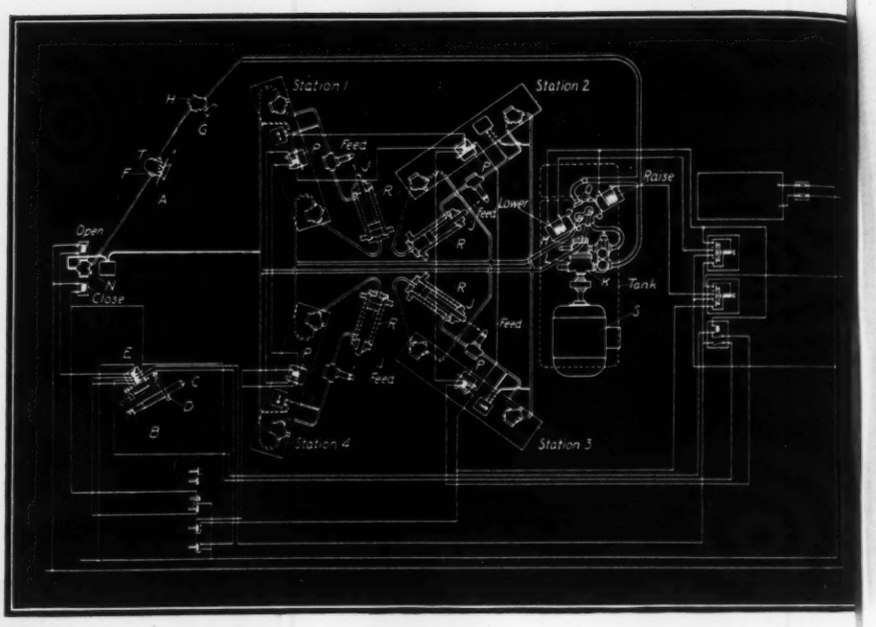
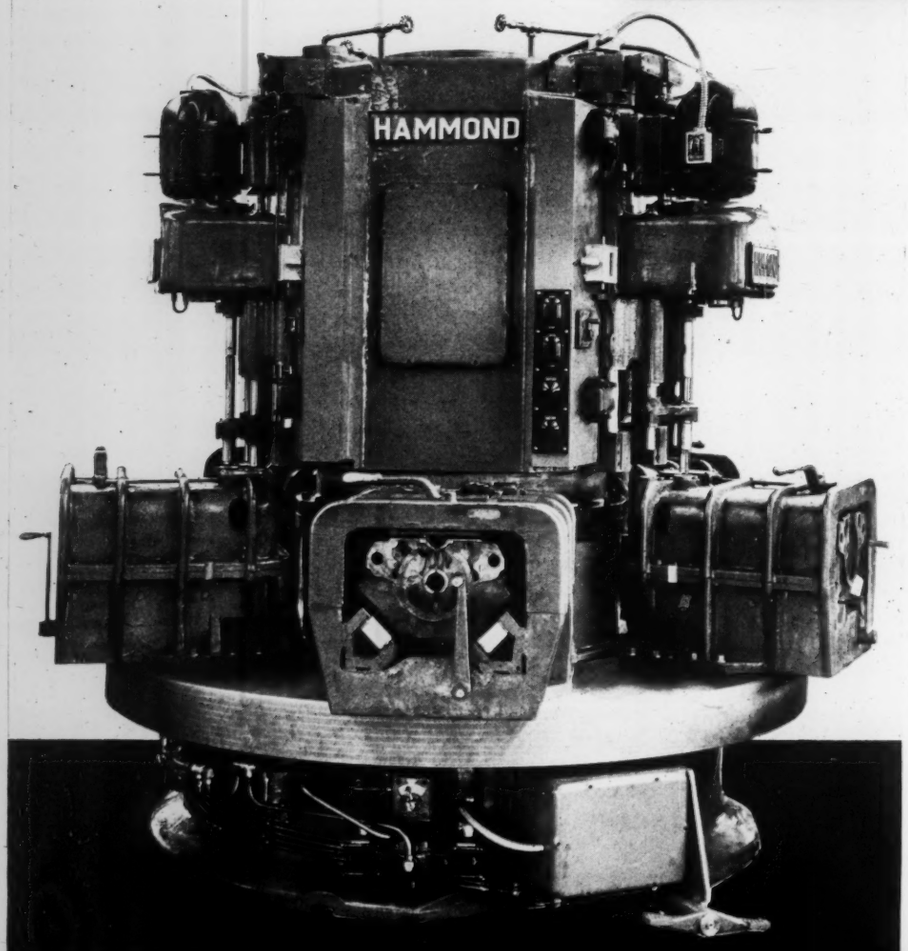


Fig. 1—Below—Heavy table of this machine is indexed hydraulically by fluid motor

Fig. 2—Right—Layout of system embodying hydraulic controls combined with electrical devices



POSSIBILITIES of the fluid motor in the design of machinery are predicated upon what already has been accomplished in the application of other hydraulic devices. This type of balanced gear unit now makes possible hydraulic indexing such as that employed in the Hammond boring and reaming machine, *Fig.* 1. The heavy table carrying five automobile cylinder blocks on which the machining operations are performed automatically, is indexed through seventy-two degrees by fluid motor *F*, *Fig.* 2, rotation being effected through the spur pinion *T* in mesh with ring gear *A* bolted to the underside of the table.

A foot pedal shown at floor

(*Concluded on Page* 67)

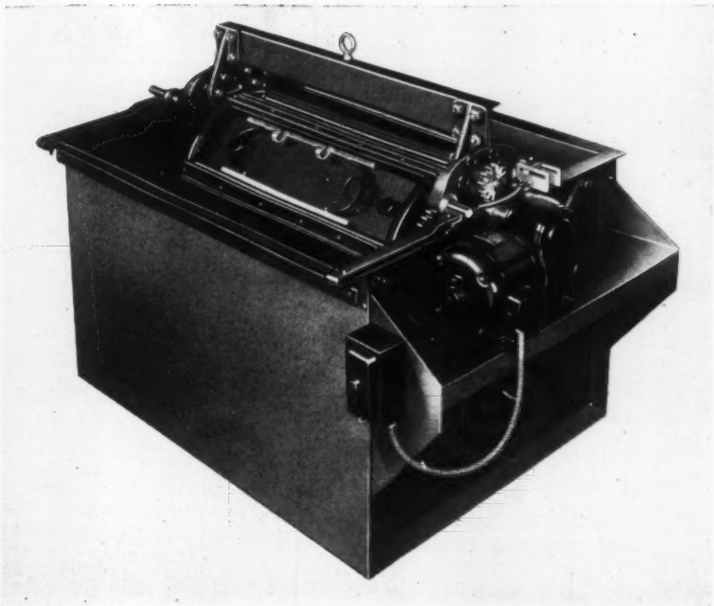


Fig. 1—Entire framework of this plating barrel is anodically charged to prevent plating of the working parts of the mechanism, a condition which if allowed would soon make the equipment useless

By John C. Bogle
The Udylite Co., Detroit

Materials Aid Electrochemistry in Plating Machine

Fig. 2—Flexible connections at points B compensate for any misalignment that might occur

DESIGN of machinery frequently involves problems that lead into branches of science other than mechanical engineering. Consequently it is not uncommon for the engineer to be called upon to combine with mechanical principles, those of the electrical and chemical fields. In developing the Udylite plating barrel, employed for bulk electropating of parts, this situation confronted its builders and only after a unique application of a principle of electrochemistry was successful design attained. By anodically charging the entire framework of the barrel, the working parts of the mechanism do not become plated, a condition which when it occurs soon renders the equipment useless.

To explain the manner in which this principle is used, it is essential first to present the factors that influenced the design of the unit, *Fig.* 1, from the standpoint of its function. Resembling in appearance and to some extent in operation the conventional tumbling barrel, this machine embodies principally a cylinder or barrel, *Fig.* 3, consisting of a skeleton structure of steel into which are fitted rubber rails and end heads. A special shock-resistant rubber was chosen for the insulating material for the perforated panels, rails and heads because it does not disinte-

grate by absorbing plating solution and it is highly resistant to wear which would result from tumbling action of work in the plating process.

During rotation of this cylinder in the plating bath contained in the welded steel tank, *Fig.* 1, mechanical stresses of considerable magnitude are set up. Moreover, the problem of resisting these stresses is complicated by the necessity of making as short as possible the solution path from the anode or plating material suspended in the solution near the edge of the tank, to the work inside the barrel. This requirement sets definite space limitations on the thickness of insulating material used. Therefore, in order to provide sufficient strength, a metal system of reinforcement for the cylinder is imperative.

As mentioned previously, the metal reinforcement such as the steel outer end plates, the staybolts which hold the cylinder together, and other metal parts which also are immersed in the plating solution, must not be allowed to receive deposits. If the designers had not taken this into consideration all steel parts, whether or not they were directly connected to the cathode terminals, would receive a plating from stray currents in the solution, which on their way from the anode to the cathode (the danglers suspended inside the cylinder in this case), radiate in widely diverse lines in the bath.

Mechanical Parts Protected

In order to permit the exposure of all metal members of this plating barrel to the plating action, the engineers electrically connect these parts directly with the anode. Accumulation of plate on the parts thus is prevented, inasmuch as plate will not form on anodic parts. The procedure was made possible by the interesting principle of electrochemistry referred to in earlier paragraphs. When two dissimilar anodes are held in electrical parallel, if one is normally insoluble in the solution, that anodic surface will build a wall of potential between itself and the solution, a condition which forces practically all electric current to pass through the soluble anode. In other words the anode polarity potential of steel is several volts higher than that of the active anode material; consequently nearly all current is diverted or herded through the latter. It is found that not only do the reinforcing parts anodically charged, remain clean and bright, but that the electrolytic action on these parts is virtually nil, contrary to what ordinarily would be expected.

A large channel iron bridge member, *Fig.* 3, to which a yoke is bolted at each end, supports the cylinder firmly in saddles at four points by means of pins fastened to the yoke. To compensate for any misalignment that might occur due to the nature of the barrel construction, self-aligning bearings have been provided at both ends of the cylinder. Spider *A*, *Fig.* 2, has three mounting points *B* which furnish a flexible connection with the cast iron gear *C* fastened to the steel end plate. On the opposite end of the cylinder a similar arrangement with a cast iron ring instead of a gear, is utilized.

Pinion *D* meshes with a gear *E* on the shaft of the gearmotor to drive the cylinder or barrel through gear *F*. Insulation of the cathode lead *G* is unbroken from the bus bar to the danglers, of which there are three to insure an ample amount of current. The cathode lead is carried to the arbor through the center of the bearing on which spider *A* revolves. Red copper encased in three layers of rubber is employed for the cathode lead. The anodically charged hanger which houses the lead protects it mechanically.

Sheet metal construction of the tank incorporates a motor support fastened to the structure by welding. The motor is guarded against overloading or single phasing by a thermo-controlled push-button switch, conveniently located, *Fig.* 1. Bakelite washers and strips as well as rubber bushings are employed as insulating members to isolate the pin *H* which acts as a terminal for the cathode lead *G*.

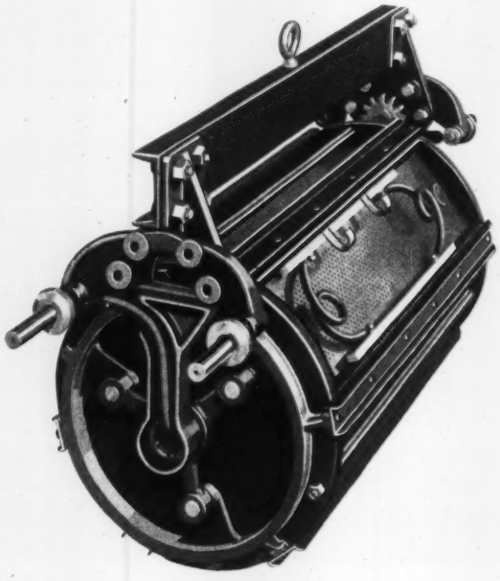


Fig. 3—Cylinder has skeleton steel structure into which are fitted rubber rails and heads

Thus by ingenious employment of modern engineering materials and a combination of mechanical and electrochemical principles there has been evolved plating equipment in which there is no treeing or freezing of slip joints. The anodically charged condition of the framework of the unit obviates a difficulty that has long been the bane of designers of machinery employed in the electroplating field.

Fluid Couplings Give Automatic Torque Variation

By Harold Sinclair

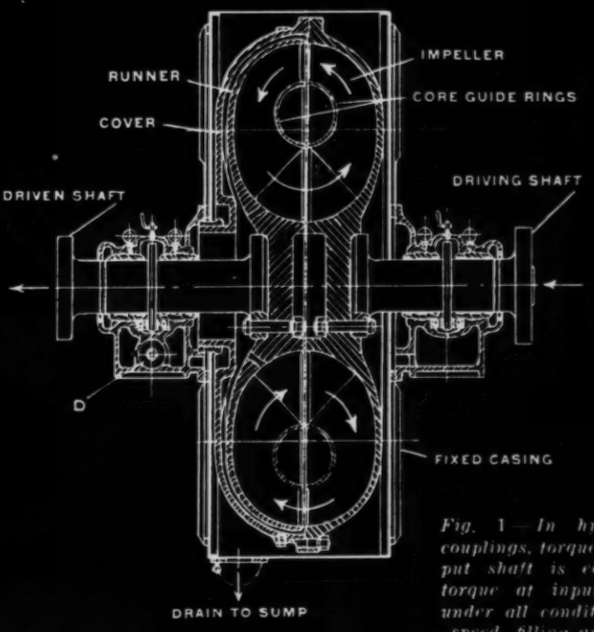


Fig. 1—In hydraulic couplings, torque at output shaft is equal to torque at input shaft under all conditions of speed, filling and slip

THE USE of hydraulic couplings in practically all fields of engineering has increased rapidly during the last few years. The author, director, Hydraulic Coupling and Engineering Co. Ltd., presents the differences between the various types of hydraulic transmissions and types of couplings and gives the field of each. The paper from which this article is abstracted was presented before the Institution of Mechanical Engineers, London.

THE FIELD of hydraulic transmission of power has for many years been the happy hunting ground of the inventor. Among the scores of such transmissions proposed during the past thirty years there remain only half a dozen that have obtained commercial success, for the reason they alone obey certain fundamental laws.

There are, broadly, two classes of hydraulic power transmitters: First the hydro-kinetic or turbo type, in which the power is transmitted by the kinetic energy of a liquid discharged by an impeller on the primary shaft against the vanes of a turbine runner on the secondary shaft. The name "hydro-kinetic" is suggested as being most descriptive of the principle involved, since the torque transmitted is dependent upon the velocity of movement of the working medium.

The second type is the hydro-static or displacement type, in which the power is transmitted by liquid delivered under pressure by a positive variable displacement pump to a constant displacement hydraulic motor, usually of the piston or eccentric vane type. The term "hydro-static" is not a very happy one, but is suggested as being the most descriptive of the principle involved, having regard to the fact that the torque transmitted is proportional to the pressure and is independent of the velocity of the working medium.

Both classes of hydraulic transmissions include examples of: Torque converters or gears, in which the output torque varies, or can be controlled, inversely as the speed; and couplings or clutches, in which the output torque is equal to the input torque and is usually provided with some degree of regulation of the slip.

Owing to the positive characteristics of the displacement type of transmission, its characteristics are strikingly different from those of turbo transmissions, and there is a considerable range of applications for which hydro-static gears are ideal, but for which turbo transmissions have little or no scope. In particular, one may mention ship's steering gears, gun-training mechanism, hydroplane controls, machine-tool feeds, printing and calender drives, and all applications of low or medium power requiring precise speed regulation over a wide range of torque and speed, and a constant speed of the output shaft practically irrespective of changes in load.

Turbo transmissions are not generally suited for such purposes, on account of the turbine characteristic that the speed is responsive to changes in the load. It is this feature, incidentally, that permits of the automatic variation of torque with speed that is so useful in the torque converter. Where the load fluctuations

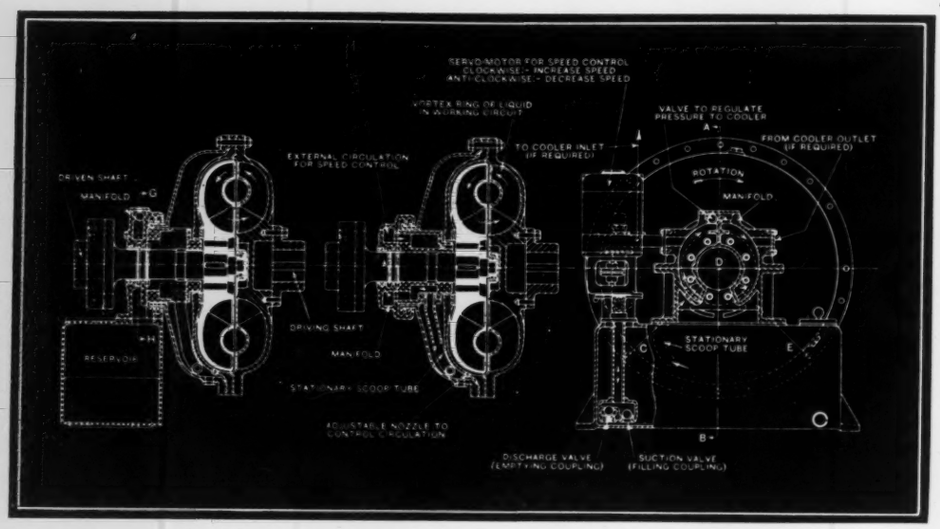


Fig. 2 — Scoop-tube type is arranged so that oil is delivered to the coupling by the tube

on a turbo-coupling of the variable filling type are not very rapid, such speed changes can be corrected by governor gear, but the natural characteristic is broadly similar to that of a shunt-wound direct current motor, or a slip-ring alternating current motor with a variable resistance in the rotor circuit. The turbo coupling is inherently simple.

There is a wide field of application in which either the hydro-kinetic or hydro-static transmission can be utilized. As regards variable speed drives, the efficiency of the hydraulic coupling with variable filling or slip control is definitely superior at the high-speed end of the range, but falls well below that of the hydrostatic type when working at a large speed reduction.

In the case of fan or centrifugal pump drives this is unimportant, since the load falls off rapidly with reduction in speed and the actual energy loss in the transmission is small. On the other hand, for constant-torque drives the hydraulic coupling offers the convenience of infinitely variable speed regulation, but gives no advantage in saving of power when running at reduced speeds. The hydraulic coupling offers further advantages in the shape of light-load starting, limited stalling torque, and flexibility of connection in both the laterial and torsional senses; but its outstanding feature is mechanical simplicity and smooth vibrationless drive.

Are of Two-Element Type

Hydraulic couplings are essentially of the two-element type having only a primary member and a secondary member, without any intermediate guide vane or reaction member such as is necessary to obtain torque conversion. The torque at the output shaft is equal to the torque at the input shaft under all conditions of speed, filling and slip.

Torque converters have essentially three elements, an impeller on the input shaft, a turbine runner on the output shaft, and a stationary guide vane or reaction member interposed in the fluid stream circulating between the primary and secondary members, and serving to change the direction of the stream of liquid in such a way as to alter the torque ratio between the input and the output shafts. The turbine and the guide vane elements may be divided into two or more stages, and the vanes may be adjustable or moveable. The guide vanes may be curved sufficiently to reverse the direction of the fluid stream, in which case the turbine runner is arranged to suit, and the transmitter becomes a reversing gear.

Pump Fills the Coupling

Referring to *Fig.* 1, the primary member or impeller of a Vulcan coupling is mounted on the driving shaft, and the secondard member or runner on the driven shaft. A cover is bolted to the impeller enclosing the back of the runner, to retain the working liquid. An annular core guide ring of semicircular section is formed with one half in the impeller and the other half in the runner. The coupling is filled by a pump through control valve *D* and a fixed casing is provided to catch leakage oil and return it to a sump tank.

The impeller and the runner are provided respectively with 28 and 26 straight radial vanes. When the impeller is rotating, and assuming the coupling to be full, the liquid in the passage between the vanes of the impeller flows radially outwards under centrifugal force. It passes across the gaps separating the impeller from the runner and flows radially inwards between the vanes of the runner until it reaches the inner diameter of the working circuit, where it returns across the gap into the inlet of the impeller and the cycle is repeated.

The three main types of hydraulic couplings are: The scoop-tube type (principally applied to stationary land plant); the traction type (used with variable-speed engines or motors to the greatest advantage); and the ring-valve traction type (used both for constant-speed and variable-speed prime movers). The traction and the ring-valve traction couplings are largely

used for internal combustion locomotives and railcars, cranes, excavators, winches, and the like. They are also used for electric motor-driven machines, such as centrifugal separators having high inertia.

The scoop-tube coupling is of the variable filling type developed particularly for use with constant-speed alternating current motors, and its range of application can most conveniently be divided into two broad groups: (1) fan and pump drives, in which the power varies substantially as the cube of the speed, that is to say, the load on the coupling decreases very rapidly as the speed is reduced, by reducing the liquid content; and (2) constant-torque drives, in which the power decreases roughly in proportion to the speed, as the slip is increased by emptying the working circuit.

Fig. 2 shows the present standard type of scoop-tube coupling, the oil being contained in a reservoir which supports the scoop-tube housing and is situated directly beneath the manifold. The manifold is provided with internal ports through which the oil delivered by the scoop-tube is circulated and returned into the working circuit. Speed is adjusted by varying the quality in the working circuit by means of a gear pump mounted on the reservoir. This pump is rotated clockwise and draws oil through the suction valve in the reservoir, discharging it into the manifold where it joins the stream of oil circulated by the scoop tube into the working circuit. Conversely, to reduce the speed, the pump is operated in anti-clockwise direction and withdraws oil from the manifold under pressure created by the scoop tube, discharging it through a spring-loaded foot valve into the reservoir chamber.

Describes Traction Couplings

Traction couplings have a reservoir chamber on the back of the runner or driven part, as shown in *Fig.* 3. The reservoir chamber *A* is connected with the working circuit by a number of tubes *B* extending into the center of the vortex ring *C* to permit of interchange of liquid from the working circuit *D* to the reservoir, and vice versa.

The most recent improvement in the traction coupling is the introduction of the anti-drag baffle, shown in dotted lines at *E* in *Fig.* 3 This baffle reduces the drag torque or creeping tendency when idling in gear, without impairing the slip at ordinary running speeds. A further effect is to cushion the action of the coupling if a sudden gear change should be made without synchronizing the speeds.

From the beginning endeavors have been made to eliminate the friction clutch in combination with the hydraulic coupling in automotive applications and to perform hydraulically the necessary operations for gear changing. The development of the traction type coupling has led the way to an improved ring valve construction and a simplified rocking clutch stop which can be used in combination with a change-speed gearbox and synchro coupling, thus eliminating a friction clutch. The new ring valve traction coupling is shown in section in *Fig.* 4. Ring valve *A* is directly mounted on a push rod *B* which slides within the driven shaft *C* and is actuated through a cotter by an external ring *D* operated by the conventional forked lever. A push-rod gland is not required, since a metal

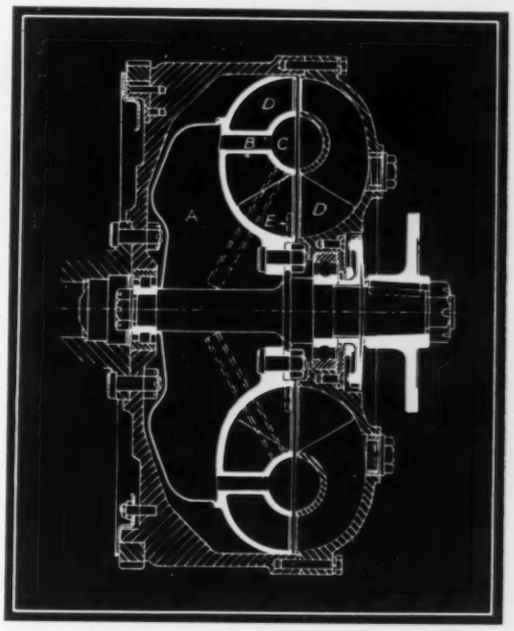
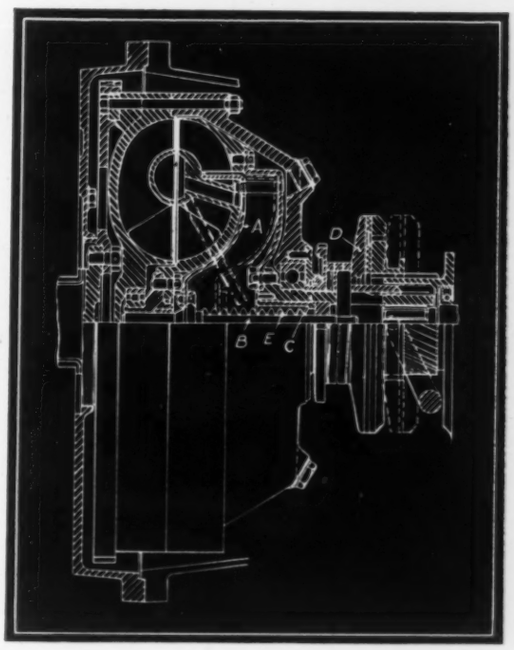


Fig. 3—Traction couplings have a reservoir chamber on the runner

Fig. 4—Simplified clutch stop aids in eliminating the clutch



bellows *E* positively seals the oil within the coupling, while permitting the necessary axial movement of the push rod.

The closing of the ring valve has the effect of reducing the drag torque of the stalled coupling to one-sixth of the drag of a normal traction coupling at the same speed. Consequently, the clutch stop can be relatively small, and it can conveniently be mounted on helical splines so as to act in the same way as a rocking brake, i. e. to impart a slight backward rotation to relieve the drag torque on the engaged gears, when it is desired to shift into neutral after the car has been brought to rest in gear with the engine idling. *Fig.* 4 illustrates a rocking clutch stop of this type which also serves to retard the rotation of the input shaft to the gearbox when changing to a higher gear.

Each new industrial application employing scoop-tube and traction couplings brings almost inevitably an unsuspected problem. This is sometimes due to the difficulty in getting full information concerning the customer's requirements, which arises from his belief that a fluid

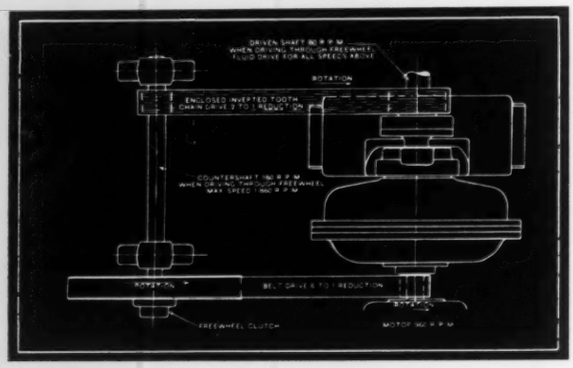


Fig. 5—Countershaft drive can be arranged in parallel with an hydraulic coupling

coupling will do all he wants, so that there can be no need to answer tedious questions.

An example of some of the problems are found in paper calenders with steel rolls, subject to a high starting torque, which rapidly drops, in the case of steel-faced rolls, to about 15 or 20 per cent as the speed increases and effective lubrication of the roll bearings is established. To enable the paper to be fed manually, it is necessary for the rolls to be rotated at about one-tenth of full speed. When this operation is finished, the calender is speeded up as desired, according to the nature of the work, the normal speed range being about 3 to 1. It is impossible during the feeding operation to maintain a stable speed by means of a hydraulic coupling, or with any machine having a similar characteristic, since the load varies as described over a range of several hundred per cent, due to the changing conditions of bearing friction. A solution of the difficulty is to arrange a countershaft drive, incorporating a freewheel, in parallel with the coupling, as shown by *Fig.* 5. When the main motor is started with the coupling empty, the drive is taken through the countershaft, which has a positive ratio of 12 to 1, and thus gives the desired feeding speed independent of roll friction variations.

When it is required to accelerate the calender, oil is fed into the coupling and the freewheel overruns when the speed exceeds 10 per cent, the drive then being taken fully by the coupling. Any desired speed over the working range of 3 to 1 can be obtained without difficulty, since the bearing friction is then substantially constant.

The hydraulic coupling offers advantages for the operation of presses used for the plastic molding industry. In the case of hydraulic presses, a traction coupling of selected characteristics is arranged between the driving motor and the hydraulic pump, so that when the press is open the pump runs at full speed, circulating the oil at low pressure through a by-pass. When the control valve is closed, the hydraulic pump delivers oil beneath the ram, causing the press to close quickly. As the press closes on the work, the pressure rises and the slip of the coupling increases, so that a smoothly increasing pressure is applied to the work being molded.

Wear is Negligible

The pump eventually stalls at a predetermined pressure of say, 1 ton per square inch, which can be adjusted by varying the quantity of oil in the coupling. It should be noted that when the pump is creating its maximum pressure, its speed of rotation is practically nil, so that wear on the rotating parts and hammering of the valves is negligible. To release the press, the control valve is opened to the by-pass. When the valve is again shut to operate the press, it closes against low pressure, and hence wire-drawing and scoring of the valve seat, as experienced on accumulator systems, is obviated.

In the case of mechanically operated presses, for which a large number of hydraulic couplings have been supplied, the method of operation is much the same, since it requires little power to close the press, and the slip of the coupling is therefore small. As the press closes, the load and slip increase, until the press stalls under the predetermined maximum load. For these applications the power usually amounts to only 2 or 3 horsepower and there is no difficulty in dissipating the heat due to the slip of 100 per cent during the period the press is closed.

The traction type of coupling with an antidrag baffle presents interesting possibilities when used in conjunction with a rotor-controlled alternating current motor or a variable-speed direct current motor having a suitable load-speed characteristic, i.e. one in which increase of load results in a decrease in speed.

New Books Cover Machine Parts, Materials, Finishes

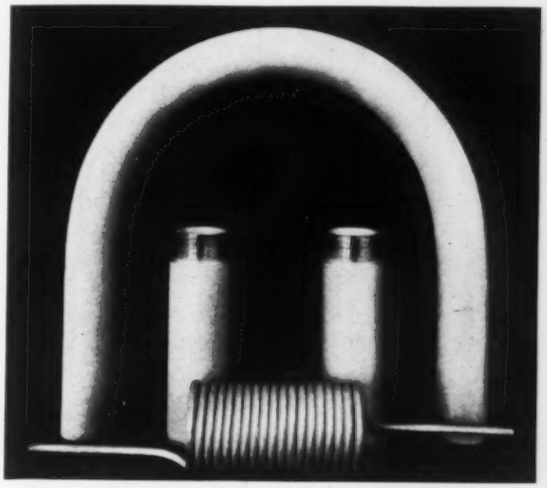
WHY not take a couple of engineering books along on your vacation? There may be intervals when the occasion would be entirely apropos to get acquainted with some of the volumes discussed in the following.

There is, for instance, the *Manual of Gear Design,* in which Prof. Earle Buckingham of Massachusetts Institute of Technology has assembled a wealth of gear information in two volumes. Section 1, because it consists entirely of mathematical tables including trigonometrical functions extended to eight decimal places, certainly has a more appropriate place in the engineering office than on vacation, but section 2 is somewhat different. This latter volume covers designing data and general information applicable to spur gears and internal gears. It also contains a list of all gear terms used throughout the book, accompanied by their mathematical symbols and terse definitions with simple drawings and diagrams to illustrate each definition. The American Gear Manufacturers association has approved this treatise.

Another new book on this subject is the *Standard Gear Book,* based on the standardized practices of recognized leaders in commercial gear production. It provides the gear designer, machinery builders and user of gears with those details covering gear design and use that are essential for efficient gear practice. Working formulas and tables supplement the text.

If you're confronted with problems involving the selection of steels, probably no better vacation companion could be found than the *Book of Stainless Steels* which Ernest Thum has edited. So rapidly has development in this field progressed that revisions have affected practically every page of this second edition. No less than 27 chapters have been re-written or are entirely new and 168 pages have been added to the number that made up the first edition. A few hours with this book on the cottage porch may banish a headache laying in wait for you at the office. The book was reviewed originally in M.D., Dec., 1933.

Perhaps the question of finishes is giving you some concern, so why not take this new book along: *Enamels,* by Prof. Andrew I. Andrews. He is an authority on the subject and has written a practical and thorough discussion of all the processes involved, from raw materials onward. Vital information presented includes tests, methods, properties, opacity, acid resistance and color. To specify enamel intelligently, the engineer must have a large share of the type of data contained in this book at his fingertips, if not in his head.



Typical illustration from "The Book of Stainless Steels," depicts 18-8 alloy tubing

And now we come to another good addition to the engineer's bookshelf, a compilation known as *Barlow's Tables* covering squares, cubes, square roots, cube roots, and reciprocals of all integer numbers up to 10,000. These well-known tables have been reset in modern type, with interlinear first differences and the addition of a column showing the square roots of numbers from 10,000 to 100,000 at interval 10. This volume, however, will look better in the office than among the vacation paraphernalia.

Further information on these books can be found on page 72.

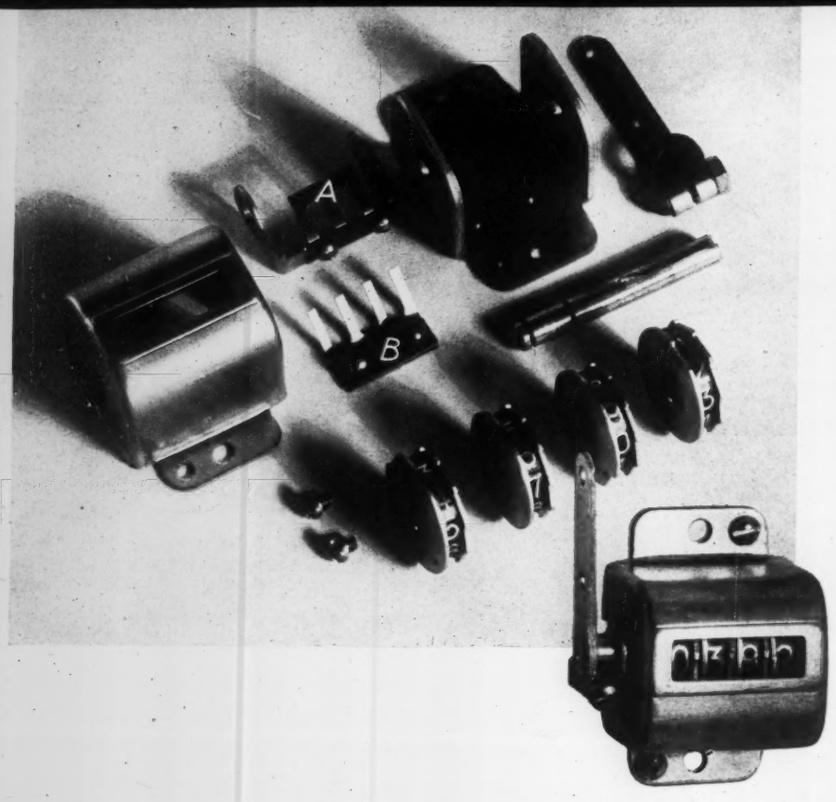


Fig. 1—Only twelve primary parts are involved in the assembly of the counter. Fig. 2—Insert—Assembly is locked together by the cover which holds the parts in correct relationship

Flat Springs Regulate Counter Operation

By L. G. Randall
Chief Engineer, Mills Novelty Co.

MACHINE users demand many qualities in an operation counter. These units, really small machines in themselves, must record every stroke, no matter how fast the strokes come; they must record only once for each number; and they must be low in price, necessitating economical manufacture. In their design, the requirements for uncompromising accuracy are liable to necessitate high production costs which will directly clash with the requirement for economy.

It was the search for a simplified design that would provide quick throw with certain register that led Mills Novelty Co., Chicago, to the development of a counter, *Fig.* 2, which discards entirely previous conceptions by employing springs instead of ratchets, and takes advantage of the economical stamping process for the majority of the remaining parts. Further, the unit is simplified to such an extent that in the final assembly there are only two screws required in addition to those needed to fasten the cover to the base (used only to hold the unit together until it is attached to the machine on which it is to count operations) and the single screw which holds the handle to the shaft. There are just 12 primary parts, *Fig.* 1, involved in this final assembly.

Operation of this unusual counter hinges upon the action of the unique flat springs which require extreme accuracy in their design and manufacture. The registering spring, *A* in *Fig.* 1, is mounted on a yoke made from a steel stamping. Two holes in the arms of this yoke fit over the shaft, one of the arms having an ear which co-operates with the keyway in the shaft and fixes the relative position of spring and shaft. This registering spring is made of 0.007 spring steel and is actually two flat springs assembled as in the illustration to act as one.

Fingers of this spring tend to move into the teeth of the number wheels unless they are kept out by the rims of these wheels. The first registering finger, at right on part *A*, *Fig.* 1, advances the "unit" wheel through contact with teeth

on the right rim of the wheel every time the operating lever indexes. The second finger will advance the "tens" wheel whenever the single tooth in the left rim of the "unit" wheel permits it to drop into the teeth on the right of the "tens" wheel. The same action takes place on the "hundreds" and "thousands" wheels which are advanced by the third and fourth fingers.

It is this method of operation which made necessary the assembly of a two-piece spring for registering rather than a spring made from a single piece. It is easily discernible that if unconnected fingers were used it would be possible for the tooth on the left of the "hundreds" wheel to allow the fourth finger to advance the "thousands" at a time when there was no corresponding advance in "tens". For this reason, the fingers for operating "thousands" and "hundreds" have cantilever arms extending at right angles over the finger for registering the next lower division. These arms, a part of the same piece as the fingers themselves as can be seen in *Fig.* 3, are offset 0.007 inch so that the inner surfaces of all of the fingers form a straight line. With this arrangement, the springs for advancing the higher wheels cannot operate those wheels unless the fingers for advancing the next lower wheel in each case drop into the tooth for that lower wheel. Thus errors in counting are obviated.

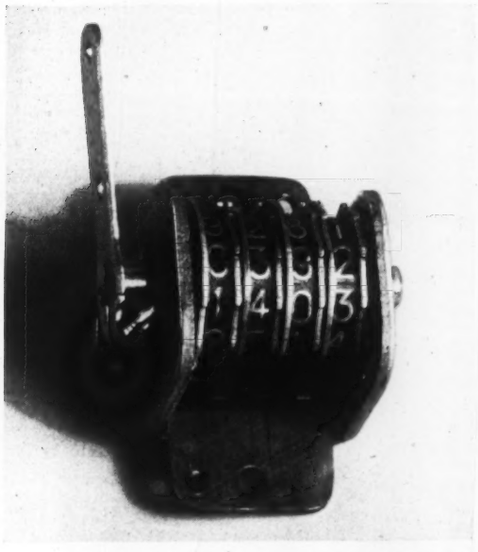


Fig. 3—*Flat springs advance the number wheels, similar springs prevent overthrow*

The braking spring, *B* in *Fig.* 1, of 0.010 spring steel, is fastened to the base and prevents the wheels from overthrowing and registering more than a single number. The fingers on this spring press into the teeth on the right of the wheels at a point behind the registering springs as shown in *Fig.* 4. Elimination of wear and danger of damage to the mechanism which might be developed by a solid stop is effected by the very nature of these brake springs, and the spring action prevents the wheels from bouncing back and creating an inaccurate count. Should the wheels go slightly past, the spring fingers tend to return them to their correct position, something a solid stop would not accomplish.

Number Plate Is Aluminum

Wheels of the counter, all of which are alike, are prepared by a simple assembly. Two stampings make up the sides, while the number plate is etched aluminum strip. These number wheels take the place of previous number wheels prepared by an expensive filling process. Ears on the number strip locate it exactly in relation to the teeth and anchor the whole together. Brass bushings are employed for the bearing surfaces, and means of staking the assembly together.

The cover of the counter is a one-piece brass stamping, drawn in one operation, white nickel plated. This method of fabrication was selected to permit high speed manufacture. It is this cover which holds the entire assembly together. As first assembled, all of the parts with the exception of the brake spring are full floating. However, the cover, fitting down over one of the grooves in the shaft, retains the parts in their proper positions. This method of lock-

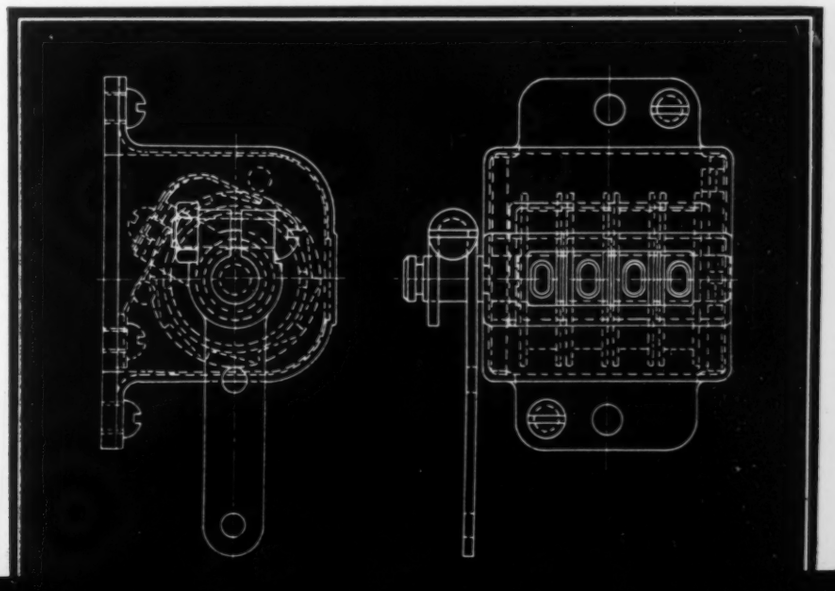


Fig. 4—*Complete assembly makes use of many stampings, interchangeable so that a single model of the counter can be adjusted for either right or left-hand operation*

ing facilitates the necessary speed of manufacture and thus assist in economical production.

The second groove in the shaft, *Fig.* 4, is included in the design to permit shifting the counter from right-hand to left-hand operation. No extra models or standard parts are needed in cases where this is desirable.

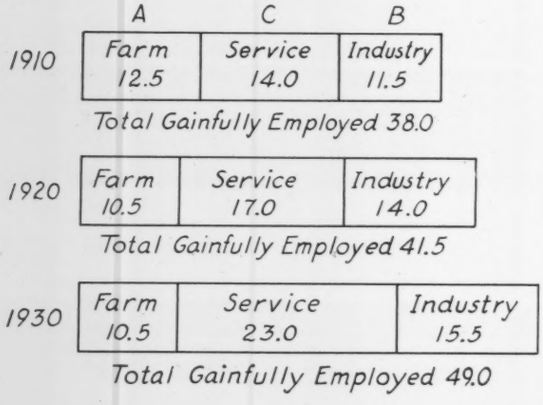
Another one-piece stamping is employed in the design of the operating lever, shown in *Figs.* 1 and 4. Here a steel strip is blanked and formed into the finished piece. The piece is given a white nickel finish before insertion of the bolt and nut. With these few production steps an operating lever is produced which duplicates the properties of levers previously used.

Nickel plating and cadmium plating are employed in the counter to combat rust and corrosion.

Development of Machinery Increases Employment

By R. E. W. Harrison*

PROBABLY no question in regard to our present day civilization has given rise to more acute debate than those relating to sufficiency of employment and technological advancement. To many of us, but particularly to engineers, there is a definite and peculiar inter-



relationship between the two subjects, inasmuch as our personal employment is in many cases solely dependent on the amount of technological advancement which we personally can generate in our specialized fields of endeavor.

The oft heard cry that the machines which we have produced and are now busily engaged in improving has taken away the livelihood of many of our fellow human beings, would, if sustained be a weighty indictment, but it is my belief that the charge is not sustained, the indictment does not hold good. We engineers have created, fortunately, many more jobs than we have destroyed, and, furthermore, through the various ramifications of our activities we have made economically attainable a relatively high and satisfactory standard of living.

Net Gain Shown

Refer to the accompanying illustration from which you will note that in the period intervening between the years 1910 and 1930, the farm industry has lost 2,000,000 workers, and the basic industries of manufacturing and mechanical industries, etc., have gained 4,000,000, a net gain on the overall situation as it affects farm and industry of 2,000,000 workers. This fact alone should answer the basic questions regarding the ability of industry to provide an increasing amount of employment in the face of a highly mechanized activity.

The greatest gain in the employment classifications, however, has occurred in the service industries, and from this same illustration it will be noted that in the period between 1910 and 1930 the service industries have absorbed an additional 9,000,000 workers. All services must be paid for primarily out of the profits generated in the basic or creative industries. In many instances the services are contributory elements in the makeup of the basic industries. However, this does not detract from the truth of the statement that elements A and B are basic, and C supplementary.

Automobile Industry Outstanding

Our available statistics show that the automobile industry is the outstanding member of the industrial community insofar as recovery from depression is concerned. This industry is probably the most highly mechanized industry in the world. During the period under review we have had constantly increasing supply of better cars at lower prices. The implications, from the economic viewpoint, cannot be avoided.

The construction industry, insofar as records are available, is the least mechanized of all the basic industries, in fact, the latest available figures show that as against the average experience of all industries the building and construction industry is 65 per cent out of line. In other words, the cost of building construction is 65 per cent in excess of what it should be, should it be considered desirable for this industry to conform to the general industrial trend.

Taking into account the manifold refinements of life which we now accept as our unquestioned right, and which are made available to us simply and solely by the availability of suitable machinery, I feel that our technicians owe the country no apology for their existence and activities.

*Abstracted from a recent address.

New Machines Indicate Design Trends

WHENEVER it becomes advisable to introduce a new machine in the production line, the plant engineer is confronted with the problem of arranging his production schedules so that the new machine will become an integral part of the system. One of the biggest difficulties which has, in the past, handicapped this work is the difficulty of arranging speeds so that the new machine will not be delayed by lack of materials or parts to it, nor will the new unit produce parts too quickly for them to be taken up by succeeding machines.

Today's designers are solving this problem for the plant engineer in increasing numbers by the incorporation of infinitely variable speed units as an integral part of their machines. There are many types and models of these units available and each will permit the new machine to be fitted exactly to the speed of co-operating machinery.

Machines recently announced in addition to those on the next two pages include the following, arranged by fields of application.

Air Conditioning

Industrial Equipment,
Crane Co.,
LaCrosse, Wis.

Unit Conditioner,
Frigidaire Corp.,
Dayton, O.

Chemical

Spray Powder and Fertilizer Mixer,
Sprout, Waldron & Co., Inc.,
Muncy, Pa.

Construction

Shovel, Crane, Dragline Models,
Link-Belt Co.,
Chicago.

Combined Electric Hammer and Drill,
Wodack Electric Tool Corp.,
Chicago.

Road Shaper,
Gledhill Road Machinery Co.,
Galion, Ohio.

Tractor Shovel,
Speeder Machinery Co.,
Cedar Rapids, Iowa.

Domestic

8mm Motion Picture Camera,
Bell & Howell Co.,
Chicago.

Electric Fan,
Acme Engineering Products Co.,
New York.

Washing Machines,
Fairbanks-Morse Home Appliances Inc.,
Chicago.

Food Mixer,
Chicago Flexible Shaft Co.,
Chicago.

Stoker,
Anchor Stove & Range Co., Inc.,
New Albany, Ind.

Industrial

Self-Cleaning, Dry Type Dust Filter,
Coppus Engineering Corp.,
Worcester, Mass.

Material Loader,
Barber-Greene Co.,
Aurora, Ill.

Sound Motion Picture Projector,
Bell & Howell Co.,
Chicago.

High Frequency Electric Screwdriver,
Buckeye Portable Tool Co.,
Dayton, O.

Ventilating Fan,
American Coolair Corp.,
Jacksonville, Fla.

Leather Working

Buffing and Shaving Machine,
Behr-Manning Corp.,
Troy, N. Y.

Metalworking

Precision Drill Grinder,
Star Electric Motor Co.,
Bloomfield, N. J.

Hydraulically Operated Lathe,
Lehmann Machine Co.,
St. Louis.

Universal Turret Lathe,
Warner & Swasey Co.,
Cleveland.

Lathe,
Sebastian Lathe Co.,
Cincinnati.

Chaser Grinder,
Landis Machine Co.,
Waynesboro, Pa.

Hydraulic Grinding Machine,
Landis Tool Co.,
Waynesboro, Pa.

Packaging

Bottle Cleaning and Filling Machine,
Pneumatic Scale Corp., Ltd.,
Quincy, Mass.

Capping Machine,
Ludcke Corp.,
Watertown, Wis.

Quarry

Constant Weight Feeder,
Hardinge Co., Inc.,
York, Pa.

Service Station

Meter Gasoline Pump,
Hayes Equipment Mfg. Co.,
Wichita, Kans.

Textile

Hosiery Machine,
Hemphill Co.,
Pawtucket, R. I.

Shear,
Curtis & Marble Machine Co.,
Worcester, Mass.

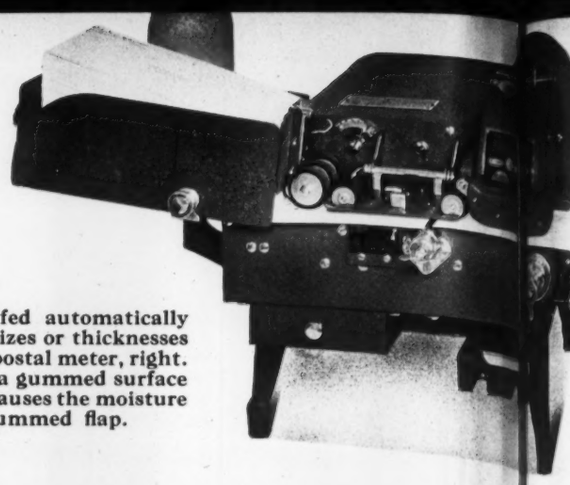
Rayon Conditioner,
Industrial Dryer Corp.,
Stamford, Conn.

Steaming-Finishing Machine,
H. W. Butterworth & Sons Co.,
Philadelphia.

Welding

Welding Manipulator
United Engineering & Foundry Co.,
Pittsburgh.

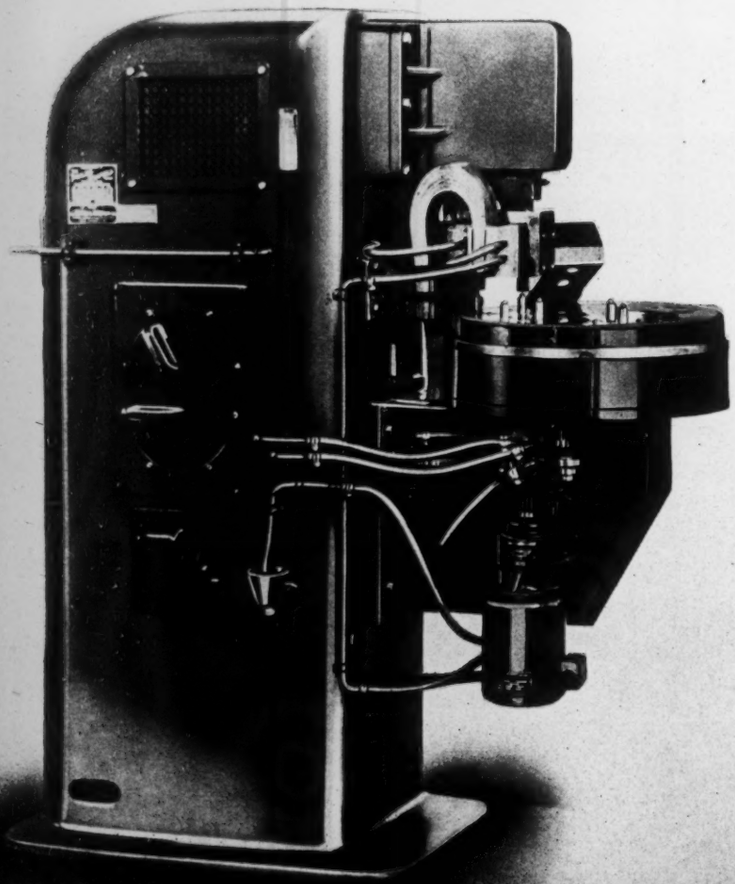
BLADES of special cast and polished aluminum alloy designed to an improved form of the Gottengen curve distribute the air from the Westinghouse Jumbo fan, left. Motor mounting to the base is made through a steel-clad rubber ring.



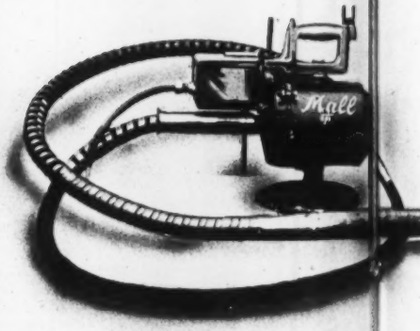
ENVELOPES are fed automatically and no special adjustment for sizes or thicknesses is necessary with the National postal meter, right. Capillary attraction in passing a gummed surface across a slot in the sealer blade causes the moisture to be deposited only on the gummed flap.

EASE of maneuvering the Hebard shop mule, right, is enhanced by three wheel construction. Resiliency for rough pavements is provided by a coil spring. Streamlined construction making use of semi-steel castings aids in improving appearance.

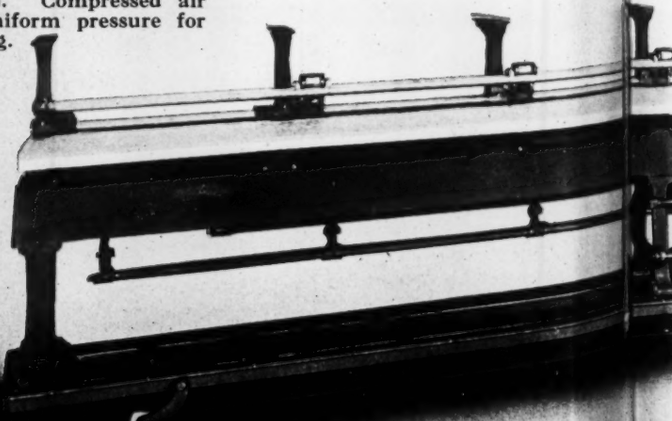
WELDED sheet steel is used for the frame of Taylor-Winfield automatic electric resistance heating machine, below. The dial is moved from station to station by a small motor through gear reduction. An air cylinder brings the upper electrodes to bear on the studs being heated.



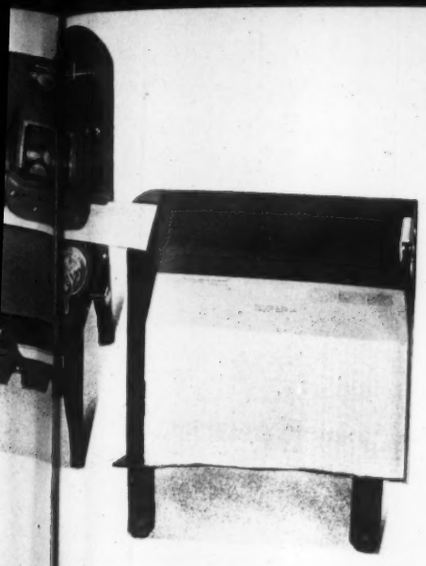
A TOTALLY enclosed dust and vapor-proof motor is employed in the Mall concrete vibrator unit, right. Flexible shafting carries the power to the tool.

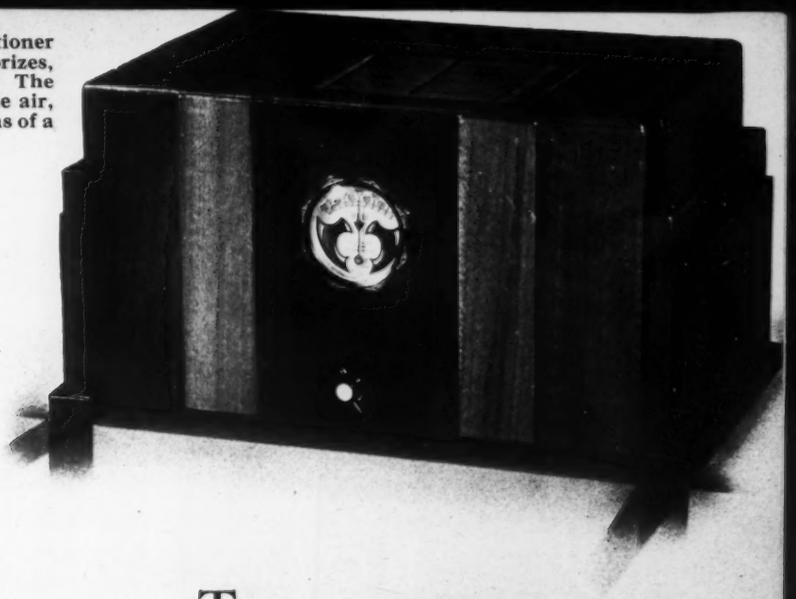


RUBBER hose making machine of Farrel-Birmingham, below, employs gearmotors and V-belts for driving. Universal joints drive the rolls of the machine. Compressed air gives uniform pressure for wrapping.



PORTABLE air conditioner includes an ionizer which deodorizes, purifies and revitalizes the air. The Corozone unit, right, circulates the air, sets up a cooling effect and by means of a filter, filters the dust and smoke.

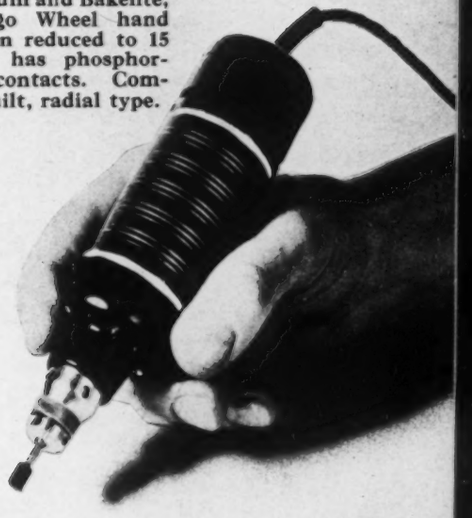


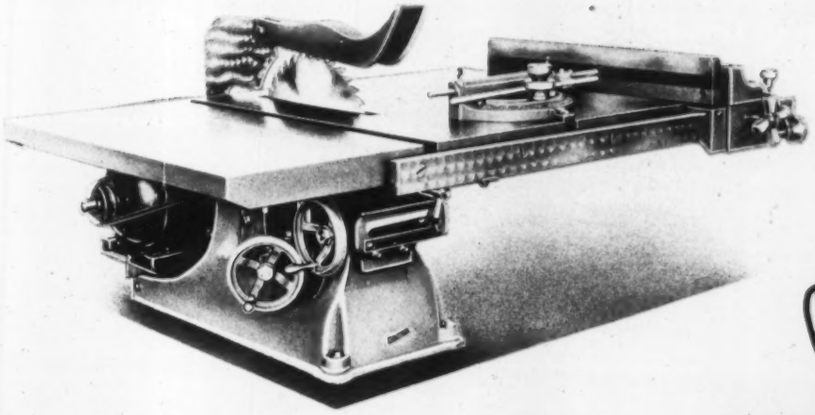


Design Features in New Machines

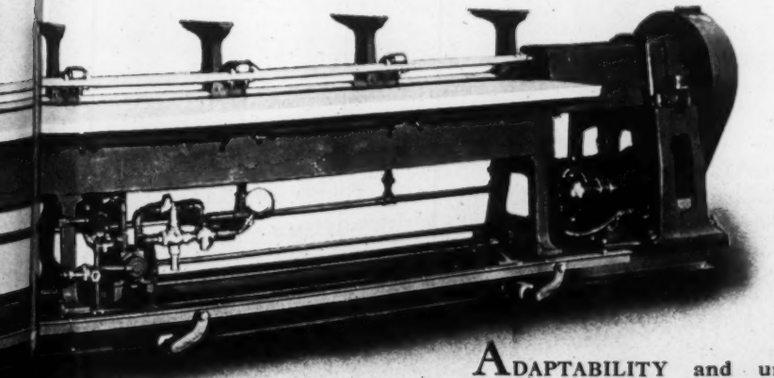
A Pictorial Presentation of Recent Machinery from the Standpoint of Design.

THROUGH the use of aluminated Duraluminum and Bakelite, weight of the Chicago Wheel hand grinder, right, has been reduced to 15 ounces. The switch has phosphor-bronze spring sliding contacts. Commutator is of the in-built, radial type.





TWO ball bearings, mounted in dust-proof housings and prelubricated, carry the spindle on new Driver bench saw, above. The arbor is raised and lowered by means of a cut steel worm and pinion.



ADAPTABILITY and universatility of Cincinnati cutter and tool sharpening machine, right, is increased by the addition of duplicate operating controls on the left side. The table slide has been made heavier and more solid.

MACHINE DESIGN

Wherein Lies the Weakness in Our Patent System?

BECAUSE fewer patents are being granted by the U. S. patent office does not necessarily imply that less vision exists in engineering circles. The difficulty today is to obtain a patent that is indisputable. It is not that applications themselves are decreasing—but what would be the sense in our patent examiners showing more leniency in granting patents when reports show that only about one in every eight fought in court is found valid? After all, there are more than two million patents already on record.

Every court case means waste, loss of time, confusion in industry, and retardation of mechanical progress. In the end, results of litigation are in many instances simply a matter of interpretation. And the interpreters are not always men of mature engineering judgment, but men who are learned in the profession of general law.

Two things are evident—examination of patent applications should be even more strict than at present (without any greater delay), and courts of patent law should be set up to handle expeditiously and equitably those cases in dispute. It is by these methods only that meaningless patents will be obviated and by which industrial concerns or single individuals—who in many cases are potential benefactors of civilization and progress—may expect their just reward.

• • •

Leaders in Design

TWO widely different types of machine often are cited by engineers as influencing present-day design—the automobile and the machine tool. To cite the most recent example of such influence it is necessary only to breathe that much-abused word "streamlining." Since the automotive industry popularized this principle (whether for aerodynamic purposes or for a combination of reasons matters little) the idea has been applied in some form or another to the design of almost every other article produced. Machine tool manufacturers have been well to the fore in adopting and furthering this trend.

Just how far designers of machine tools have gone in utilizing the smooth-flowing lines and built-in construction inherent in so-called "streamline" design will be clearly portrayed at the Machine Tool congress in September, the first to be held in six years. Many lessons will be carried away from this exhibition of modern machinery.

For those readers of MACHINE DESIGN who may be unable to visit the show, and to summarize the most important developments in machine tools in a single issue, the September number of this journal will be devoted throughout to machine tool design.

PROFESSIONAL VIEWPOINTS

Machine Design Welcomes Letters Suitable for Publication

Designing Pivoted-Motor Drives

To the Editor:

DR. TATNALL'S paper on "What's behind the Pivoted-Motor Drive," published in your May issue, is an interesting and clear presentation of the mathematics involved together with other relevant information. Pivoted motor bases are becoming progressively more widely used on all kinds of motor drives. There are now at least five different makes of such bases on the market.

The following paragraph in Dr. Tatnall's paper seems to need some further explanation.

> "But—and this is important—having, in the derivation of formulas for the tensions, introduced the motor torque in terms of horsepower and speed as by the factors P and k in equations (3) and (4), the motor torque itself must then be forgotten, and is now represented by the *changes in tension* which it has produced and which would not exist without it."

When the load on a fixed center drive is increased T_1 increases and T_2 decreases but T_1+T_2 remains practically constant from zero load to peak load. This statement is not at all true for a well designed motor base drive in which case T_1+T_2 must always increase with each load increase and vice versa. A total belt tension that is small at no load and one that follows the motor torque up to a peak and back again, i.e. a total belt tension always proportional to the motor torque is a new idea in power transmission engineering. Motor torque certainly should not be forgotten because it is just as important as the last half of Dr. Tatnall's formulas (3) and (4). $ew/(a+b)$ in both of these formulas should be labeled that part of T_1 or T_2 due to gravity while $bkp/(a+b)$ should be labeled that that part of T_1 or T_2 which is due to reaction torque.

The relative magnitude of $ew/(a+b)$ (gravity effect) and $bkp/(a+b)$ (reaction effect) in any motor base drive is an accurate measure of drive performance in terms of desirability from the customers point of view. The larger the reaction part of total tension the lower the initial tension may be for the same peak load tension and the lower the average belt tension and bearing pressure some of the advantages of much lower average belt tension are lower friction losses, (or longer bearing life if anti-friction bearings are used) lower bearing maintenance costs, less probability of hot bearings and bearing burn outs, less belt stretch and longer belt life. The tendency is definitely toward "across the line" starting of large motors with a high peak torque as compared to full load torque. A well engineered drive must have sufficient belt tension to prevent serious slip at peak load. Unless the drive is designed so that the reaction effect is intelligently used this high belt tension and its corresponding high bearing pressure must be maintained all the time regardless of the need for it. The correct belt tension for 9/10 of the time may easily be 1/5 of what is required for peak load.

To obtain really desirable performance as thus defined the a of Dr. Tatnall's formula (3) & (4) must usually be negative, that is the pivot point of the motor base must come between the belt strands and near the motor axis; it certainly must above the plane of the motor feet.

—WALTER J. COPPOCK,
American Pulley Co.

Output Stroke Is Variable

To the Editor:

IT IS often essential that simple mechanism be designed in which it is possible to vary the output stroke, even though the input stroke be constant. One such method is shown in the accompanying illustration which shows two of the four slides of a special flat wire forming machine. For clarity's sake the feeding and cutting off devices which were of conventional design and which were located adjacent to the four slides have been left out.

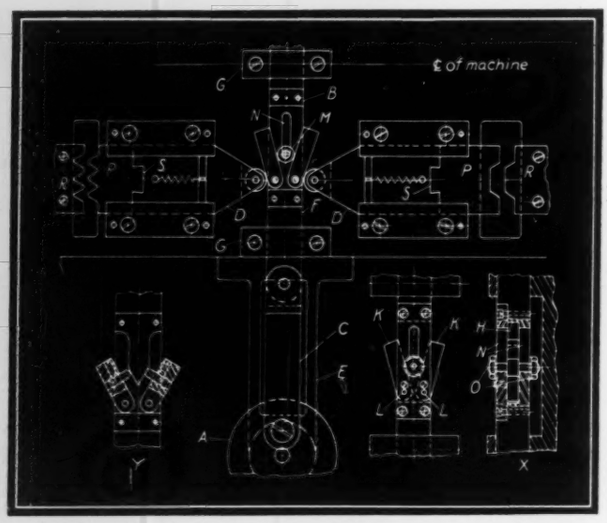
For each revolution of constant eccentric A, slide B through connecting rod C operates four slides D. On the forward stroke it operates the slides on the opposite side of the center line causing them to close. On the return stroke they open, and the slides shown close. Thus at each half revolution two parts are formed.

The construction essentially consists of eccentric A supported by bracket E connected to cam slide F by means of connecting rod C. Cam slide F is restrained by guides G. At H, cam slide F is milled out as shown in view X to accommodate the two adjustable cam surfaces K. These cam lugs are pivoted at L and are adjust-

ed as to angularity by means of the roll *M* which rides in slots *N* in the cam slide. When adjustment has been made, screws *O* are tightened and the adjustment is completed.

In this particular machine, forming jaws *P* are arranged to be removed from the slide by the simple dovetail arrangement shown at *S*. Form blocks *R* are screwed and doweled in position and backed by a substantial solid surface.

If it is desired to give one form slide a greater adjustment than the other, this can be accomplished by employing the method shown in view *Y* which allows independent adjustment of the form slides.



Output stroke may be varied even though the input stroke is constant

—John A. Honegger,
New York

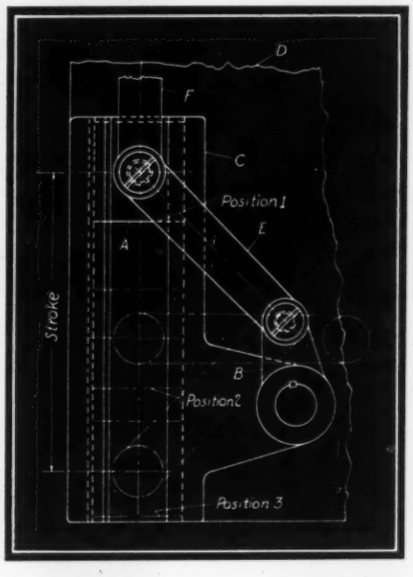
Doubling Lever Oscillations

To the Editor:

An ingenious mechanical movement employed in a bag closing machine is a sliding crosshead which imparts two cycles of movements to an oscillating lever for each cycle of the crosshead. This movement is shown in the accompanying illustration, the crosshead being indicated at *A* and the oscillating lever at *B*. The crosshead receives its motion from crank-driven link *F* and slides in guide *C* which is cast integral with machine frame *D*. It is connected to the oscillating lever by link *E*.

Three positions of the crosshead and link *E* on the downward stroke are indicated in full and in dot and dash lines. In position 1, the lever is at the limit of its movement toward the left. When the crosshead reaches position 2, the lever is moved to its extreme righthand point. As the crosshead reaches position 3, the lever is returned to the position shown. Thus, the lever is moved through a full cycle on the downward stroke of the crosshead. Consequently, when the crosshead has completed its cycle of movements, the lever will have been moved through two full cycles.

By modifying the length of the lever and the stroke, the angular movement of the lever may be varied to suit other applications. It will be noted that the second oscillation of the lever occurs during less than one-half of the downward stroke of the crosshead. This movement, which results in a change in the angular velocity of the lever, was desirable in the machine mentioned. However, if each stroke must be completed in the same time, this can be accomplished by locating guide *C* in a suitable angular position; or the same result may be obtained by having the movement of the lever equal on both sides of a vertical center line passing through the lever shaft.



Two cycles of motion are imparted to oscillating lever for each cycle of the crosshead

—J. E. Fenno,
Belleville, N. J.

Elongation Is Corrected

Elongation of the material mentioned in the next to last paragraph of "Yield Point Is Paramount," by D. P. Forbes on page 24 of the May issue of Machine Design, which has a tensile strength of 90,000 pounds and a yield point of 70,000 is 6 per cent in 2 inches. This elongation was reported incorrectly in the article. The other material mentioned in the paragraph, having a tensile strength of 70,000 pounds per square inch and a yield point of 50,000, has an elongation of 16 per cent in 2 inches.

MEN OF MACHINES

RISING through the ranks of the International Harvester Co., Sydney G. McAllister now becomes president after 38 years' affiliation. His first connection was in 1897 when at the age of 18 he became an office boy at the McCormick works, Chicago. Going to the Auburn, N. Y., works in 1908, he was made superintendent there two years later.

His company sent him to Europe in 1914, where after three years he was appointed works manager. Recalled to the United States in 1931, Mr. McAllister was elected vice president in charge of engineering, traffic, fiber, and patent departments. Subsequently he was placed in charge of the manufacturing and engineering departments, and in May, 1934, assumed the office of first vice president.

SYDNEY G. MCALLISTER

• • •

MEMBERS of the American Gear Manufacturers association have chosen A. A. Ross as their new president. He had been long active in the group, serving as vice president and also as chairman of the general standardization committee.

On graduating from Pictou academy in Nova Scotia in 1894, he entered the employ of the General Electric Co. as a machinist apprentice. After completing an engineering course in night-school in 1897, Mr. Ross joined the railway engineering force in the development of gearing used in transportation equipment.

In 1923, when his company consolidated the manufacture of all types of gearing at its West Lynn, Mass., plant, he was placed in charge of the centralized engineering and manufacturing gear departments. In this capacity he continues to serve.

A. A. Ross

• • •

THE new director of research at Lukens Steel Co. is Erle G. Hill. He comes to that organization from Mellon Institute of Industrial Research, where in 1930 he accepted a fellowship. A native of California, he was born in Santa Ana in 1890.

Graduating from University of California in mining and metallurgical engineering in 1913, Mr. Hill took graduate work there, at Carnegie Institute of Technology and at the University of Pittsburgh. Subsequently he engaged in mining and metallurgical work in the Western states and in Mexico.

Carnegie Tech had him as an instructor in mining and metallurgy from 1918 to 1920, when he became associate professor of metallurgy at the University of Pittsburgh. During the ten years he served that school he also functioned as consultant for various

ERLE G. HILL

companies. Mr. Hill is a member of the A.I.M.E.., A.S.M., A.S.T.M., and the Franklin institute.

♦ ♦ ♦

THEO. BROWN has been awarded the Cyrus Hall McCormick gold medal for 1935 by the American Society of Agricultural Engineers. He is affiliated with Deere & Co., and holds many patents pertaining to farm equipment.

♦ ♦ ♦

DR. CHARLES L. FAUST recently joined the technical staff of Batelle Memorial institute, Columbus, O., as electro chemist. Other new members of the staff include DR. H. R. NELSON, MYRON R. NESTOR, PHILIP C. ROSENTHAL and DR. BRUCE A. ROGERS.

♦ ♦ ♦

E. L. MORELAND has been appointed head of the department of electrical engineering at Massachusetts Institute of Technology. He will continue his active affiliation as senior partner in his firm, Jackson & Moreland.

♦ ♦ ♦

DR. L. B. TUCKERMAN, principal scientist and assistant chief, division of mechanics and sound, National Bureau of Standards, delivered the tenth Edgar Marburg lecture at the recent annual meeting of the American Society for Testing Materials in Detroit.

♦ ♦ ♦

COL. EDGAR S. GORRELL, president of Stutz Motor Car Co. of America Inc., has been appointed chairman of the Collier aviation trophy committee for 1935. Other members of the committee are MAJ. JAMES H. DOOLITTLE, CHARLES L. LAWRANCE, W. B. STOUT and EDWARD P. WARNER.

♦ ♦ ♦

F. O. CLEMENTS, who is technical director, Research Laboratories, General Motors Corp., has been appointed to represent the American Society for Testing Materials on the division of engineering and industrial research of the National Research council.

♦ ♦ ♦

A. J. MURPHY, noted British metallurgist, will present the 1935 official exchange paper of the Institute of British Foundrymen at the annual convention of the American Foundrymen's association at Toronto, Ont. The paper will deal with high strength cast bronzes.

♦ ♦ ♦

K. B. MCEACHRON, General Electric research engineer at Pittsfield, Mass., has been awarded the Franklin institute Edward Longstreth medal for the development of Thyrite, a substance used in more than thirty-five different electrical applications.

♦ ♦ ♦

JOSEPH H. GEPFERT, Cleveland district manager of Reeves Pulley Co., recently was elected president of the Cleveland Engineering society. New directors include WARD HARRISON, director of engineering, General Electric Co., Nela Park, and C. CLARK WALES, chief engineer, Otis Steel Co.

♦ ♦ ♦

E. G. MCKIBBEN, who is associate professor of agricultural engineering, Iowa State college, and C. O. REED, now professor of agricultural engineering at Ohio State university, recently were elected to serve two years each as members of the advisory committee of the college division of the American Society of Agricultural Engineers.

♦ ♦ ♦

H. H. WOOD, until recently manager of the rolling mill division of Timken Roller Bearing Co., has joined the engineering staff of Morgan Construction Co.

♦ ♦ ♦

GEORGE S. KELLEY, New York, was awarded a certificate of merit by Franklin institute for the invention of an apparatus for removing dust produced in the drilling of rock.

♦ ♦ ♦

H. S. VASSAR, laboratory engineer, Public Service Electric & Gas Co., Irvington, N. J., recently was elected president of the American Society for Testing Materials.

♦ ♦ ♦

ALFRED K. MARTIN has been appointed vice president, director and chief engineer of Forging & Casting Corp., Ferndale, Mich., a subsidiary of Ludlum Steel Co.

♦ ♦ ♦

O. W. MCMULLAN recently joined the research staff of International Nickel Co.

♦ ♦ ♦

DR. IRVING LANGMUIR, head of the General Electric research laboratory, was awarded the Alexander Holley medal by the American Society of Mechanical Engineers recently.

♦ ♦ ♦

F. H. ROSENCRANTS, at one time chief engineer of International Combustion Ltd., England, has been elected vice president of Combustion Engineering Co. Inc., and will have charge of the proposition engineering department.

♦ ♦ ♦

CONRAD MATSCHOSS, honorary member of the American Society of Mechanical Engineers, has resigned as director of Verein deutscher Ingeneure in Germany in order to devote his time more intensively to his historical work.

Obituaries

MARCUS T. LOTHROP, former president of Timken Bearing Co., died recently in Canton, O. He was fifty years old. Nationally known as an engineer and metallurgist, Mr. Lothrop was a graduate of the University of Michigan and Joined Timken in 1911 as chief metallurgist.

♦ ♦ ♦

HENRY W. TIDEMAN, widely known in the electrical field, died recently. Retired for the past eighteen months due to a prolonged illness, Mr. Tideman prior to that time served as vice president in charge of engineering of the Signal Electric Mfg. Co., Menominee, Mich.

♦ ♦ ♦

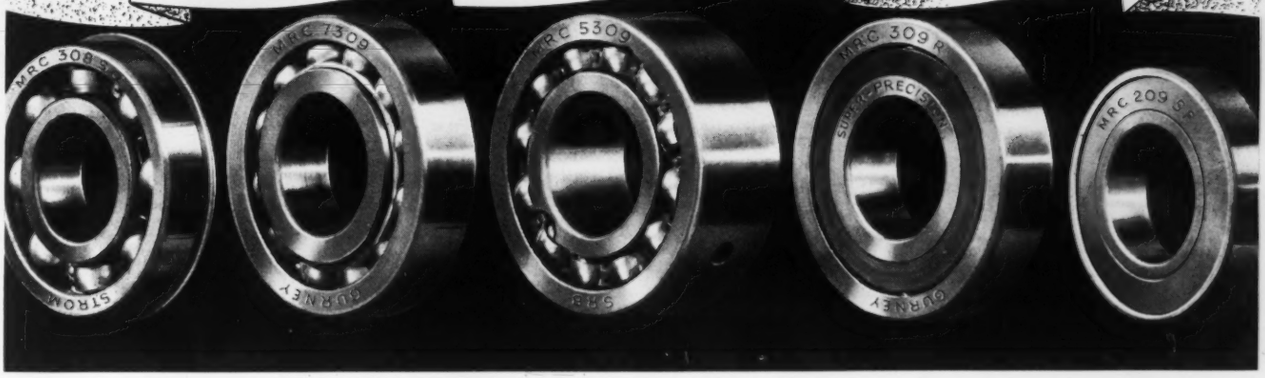
FRANK H. STREINE, well-known designer and builder of metal finishing machinery and head of the finishing machinery division of Mackintosh-Hemphill Co., Pittsburgh, died recently from injuries sustained in an auto accident. For many years he was vice president and general manager of Streine Tool & Mfg. Co., New Bremen, O., and only recently was appointed to his new position with the Pittsburgh organization.

M-R-C

BALL BEARINGS

INDIVIDUALLY FAMOUS AS

STROM GURNEY SRB



M-R-C Strom SRB Gurney Ball Bearings

BACK of every M-R-C Ball Bearing is a distinguished reputation for uniform high quality. It is a reputation built with 37 years of manufacturing experience . . . of outstanding achievements in bearing design . . . of constant effort to provide bearings of finer accuracy and greater capacity.

M-R-C Ball Bearings offer the extensive variety of 23 proven designs backed by years of experience and competitive testing logically expected from a pioneer and leader.

Marlin-Rockwell Corporation

Leadership

EXECUTIVE OFFICES . . . . . JAMESTOWN, N. Y.
FACTORIES: JAMESTOWN . PLAINVILLE, CONN. . . CHICAGO

TOPICS

PROGRESS in engineering was reflected impressively in the fifty-seven technical papers presented at twenty-seven separate technical sessions at the recent semiannual meeting of the American Society of Mechanical Engineers in Cincinnati. Materials handling, education and training, prefabricated housing, hydraulics, drying, waste elimination, steam power, lubrication, color, aeronautics and various other subjects were covered. An advance abstract of a paper on power transmission, "The Pivoted-Motor Drive," appeared in MACHINE DESIGN, May issue.

The place of the engineer in social progress was discussed by Ralph E. Flanders, president of the society, in the feature address given at a banquet at which Dr. Irving Langmuir was awarded the Holley medal for 1934. The next semiannual meeting of the society will be held in Dallas, Tex. In December the annual meeting will of course be held in New York as usual.

• • •

New Standard Covers Washers

Now being distributed for criticism and comment is the proposed American standard for plain washers for use with American standard regular bolt heads and nuts. Copies are available on application from C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York.

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Accidents Increase in Machinery Industry

Accident rates in the machinery industry for 1934 were higher than those of 1933, according to figures just released by National Safety council. Frequency of rate is two per cent higher and the severity ten per cent. Despite the rise in rates, however, machinery manufacturers have a much better accident record than many other industries. Since 1926 the industry has made greater improvement in severity rates than others, although it has failed to make average progress in frequency. Thus, the machinery industry has accomplished a forty-nine per cent decrease in frequency since 1926, as compared with fifty-seven per cent for all industries, and a forty-three per cent decrease in severity compared with a thirty-seven per cent decrease for all others.

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Who Said Streamlining Was New Idea?

Records reveal that a patent for a streamlined train was granted in 1865 by the United States patent office to Samuel R. Calthrop, Roxbury, Mass. The fact that it took seventy years for the idea to gain acceptance is cited by the Inventors Foundation, New York, as evidence that inventors with an eye to profiting financially from their inventions will do well not to pioneer too far in advance of current custom and usage. While the principle was as good seventy years ago as it is today, railroads were not ready for streamlining, largely because neither the diesel engine nor the light weight materials such as high strength steel or aluminum then were available.

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A.G.M.A. Eases Engineers' Problems

A noteworthy contribution to design and application of speed reducers has been made by the American Gear Manufacturers association in adopting recommended practices for rating helical and herringbone speed reducers and heavy duty worm gear reduction units. For years, purchasers of this class of equipment have been confronted with the difficult problem of reconciling the conflicting engineering practices that have prevailed among gear makers.

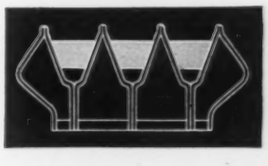
The A.G.M.A. appointed technical comittees that have spent several years in working out recommended practices for adoption by the asso-

SILENCE

Noise destroys efficiency. Noise elimination is moving upon us rapidly; in some cases through legislation, in some cases through individual initiative. Duro-Brace Texsteel Drives anticipate the future and step beyond the immediate present to meet it . . . they are silent as burning candles. • They are not silent by chance. They have been made silent with a purpose; for medical science has firmly established the fact that clashing, grinding or screeching noises cause distraction and that steady humming or whirring noises dull the senses and cause drowsiness. Both distraction and drowsiness result in inefficiency. • That is why modernization groups and efficiency experts are acting more and more to eliminate noise. Duro-Brace Texsteel Drives invite the closest examination by all such groups and experts. • Duro-Brace Texsteel Drives are silent, 98.9% efficient, strong, vibrationless, slipless, shock-absorbing, require no belt dressing or lubrication and are not affected by dirt or moisture. • Write us for Bulletin 2188 which sets forth the advantages that Duro-Brace Texsteel Drives offer you in all matters of power transmission, whether they be simple or complex.

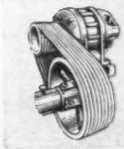
★ ★ ★

New Duro-Brace Design: cross-section showing outside plate braced by a convex reinforcing steel plate.



Former Design: cross-section showing unsupported outside plate.

TEXROPE DRIVES



ORIGINATED BY

ALLIS-CHALMERS MANUFACTURING

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COMPANY • MILWAUKEE, WISCONSIN

ciation. That these recommendations have had the almost unanimous endorsement of the industry is proof of their desirability and value. Different types of service that are encountered in every-day use are indicated by service factor or class, so that the buyer of a speed reducer now can be assured of obtaining the proper unit for his needs.

• • •

Ball Bearings Take a Boat Ride

The Swedish engineer, Dr. F. Ljungstrom, is making use of ball bearings in mounting the mast of a sailing yacht. His design allows the sail to be wrapped up like a window shade. A pull on a cable rotates the mast and winds up or lets out the canvas, making it possible to make or take in sail in a few seconds. The blunt, rounded nose instead of a sharp prow is another innovation that has aroused interest among Swedish yachtsmen.

• • •

Welding Again Cuts Weight

Built by welding, a huge 25-ton salt evaporator recently was constructed by Wellman Engineering Co. Arc welded steel, replacing cast iron, saves approximately fifty per cent of the weight and materially reduces cost. As proof of its strength, a crane yanked the evaporator by the neck from prone position and stood it on end. A bronze propeller stirs up the wet salt which is circulated through 828 copper tubes, distilling off the water.

• • •

Technical Survey Promises Guidance

United States bureau of labor statistics, now has underway a survey of the engineering profession, made at the request of the American Engineering council. It is hoped that the information obtained will be of service to engineers, particularly under such conditions as have prevailed during the past five years, and a guide to those who are preparing to enter the profession. A questionnaire is in the course of distribution among technical men throughout the country by the department of labor, Washington.

• • •

Wouldn't This Be Infinitely Variable?

California Institute of Technology at Pasadena has in operation a super gearshift with 11,011 distinct speeds. Probably the most complicated gearshift ever assembled, it consists of a score of toothed gears with four shift levers, each of which may be set up in ten different positions. The unit is employed for governing speed in connection with electric motor-driving apparatus used to test pumps for the Colorado river aqueduct. The possible pump speeds start at one-half a revolution a minute and increase by half-revolutions to 5000 revolutions per minute.

Watch the Motorist with a Dark Car!

General use of motor cars painted in light colors would greatly reduce the number of traffic accidents, W. A. Lindberg, Chrysler color engineer, contends. He has made an informal check on motor car collisions and has found that in a large percentage of the cases either one or both cars involved were painted black or some other dark color. This color factor is particularly important at night when superior visibility of the lighter cars is more pronounced than in the daytime.

To Remind You That—

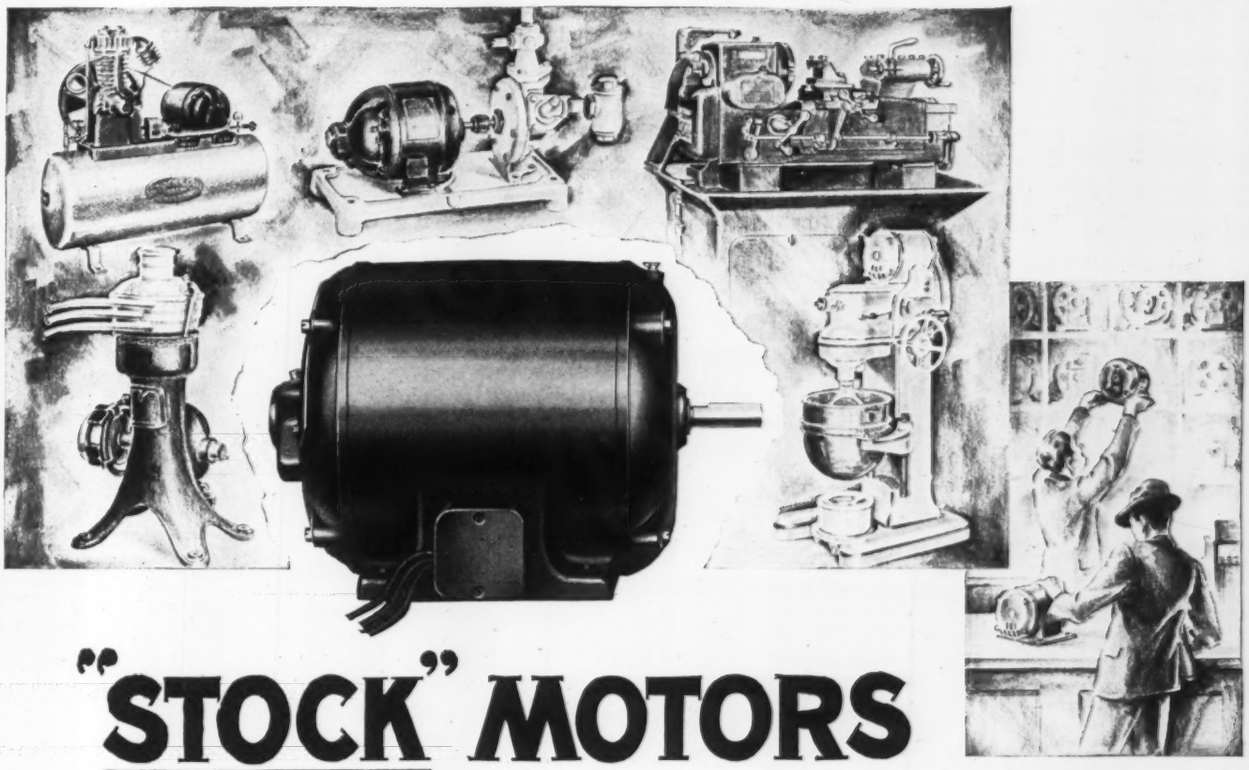
On page 15 commences an article which discusses a machine for solving difficult mathematical problems. You've probably heard about this differential analyzer at Moore school of electrical engineering, University of Pennsylvania, and will want to know how it operates. Some good ideas are employed.

Hydraulics every day finds new applications in design. It may be the missing link in the evolution of your new machines. The use of a fluid motor for indexing (page 26) and the article on hydraulic couplings (page 29) are presented to show some of the new advantages of this principle.

If you are working on parts that require plating, the design employed in a new plating barrel (page 27) may help you. The idea of anodically charging the metal structure of the machine prevents a lot of trouble.

Recorders are coming into greater use on machines. One of these (page 34) has been simplified to facilitate assembly. Springs are used effectively.

The second part of Prof. Maleev's series on a new approach to design problems involving the determination of stresses in materials (page 22) continues a discussion that has aroused considerable interest among engineers.



"STOCK" MOTORS

Many of America's leading motor-driven machines and tools made their entry into the field powered with stock type Emerson fractional and integral horsepower motors.

The reasons are evident. Emerson Motors are always dependable. They are rugged. Many are still in daily use after thirty-five years of service. They are efficient, accurately designed, precision built, carefully assembled, and tested by skillful hands.

The selection of a motor is determined by the construction and specified duty for which the machine is intended. Hundreds of Emerson stock type motors, from which to choose, are available for prompt shipment. Large Factory Stocks are available at conveniently located shipping points.

The Emerson Engineering Staff will analyze your problems and recommend the type required to give your machine an Emerson motor of proper horsepower—speed rating—torque—power factor—and efficiency. Sample motors will be furnished for test purposes. Start your investigation by writing for bulletin 9M—TODAY. No obligation.

Portion of room where endurance tests are conducted on motors operating intermittently and continuously. From these tests the life span of the various motor parts is determined.

Individual Engineering Service

There are scores of standard uses for high quality, Standard Motors. Emerson supplies them every day—has for 45 years. But with the rapid development of new motor-driven machines and tools there is a constant demand for individual engineering service—for specially designed motors to fit specific needs. These needs frequently call for a hair's breadth difference—a difference, however, that makes a champion instead of a runner-up. Emerson has won recognized leadership in the motor industry because of its ability to supply individually designed or Standard Motors for practically every type of motor application.

EMERSON MOTORS

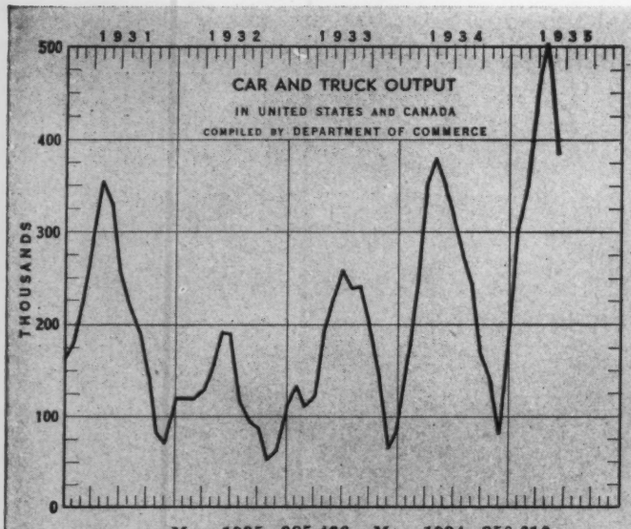
3 HP and smaller—Single-phase—Polyphase—Direct Current

THE EMERSON ELECTRIC MFG. CO.

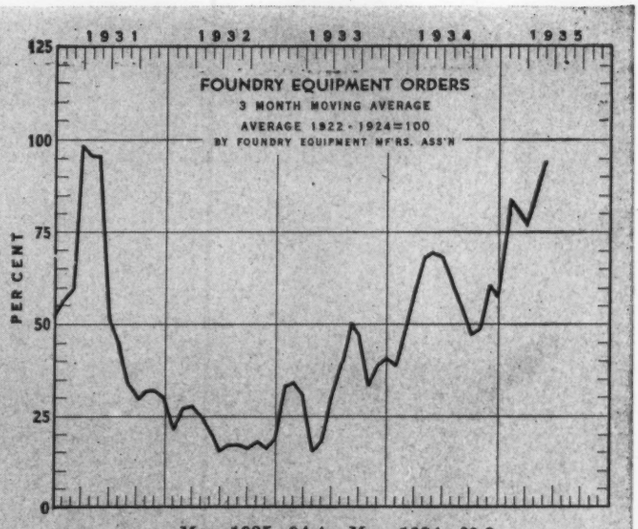
NEW YORK ST. LOUIS CHICAGO

LEADERS IN THE FAN AND MOTOR INDUSTRY SINCE 1890

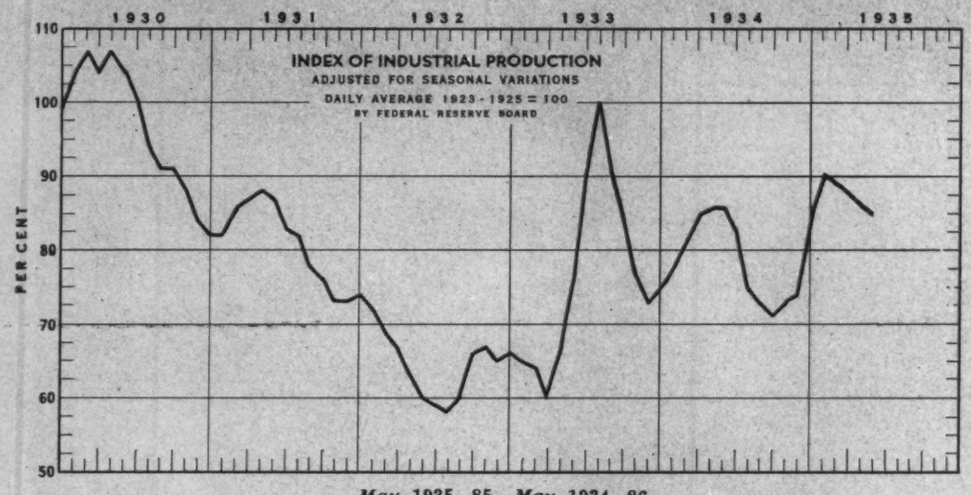
How Is Business?



May 1935, 385,486—*May* 1934, 350,616

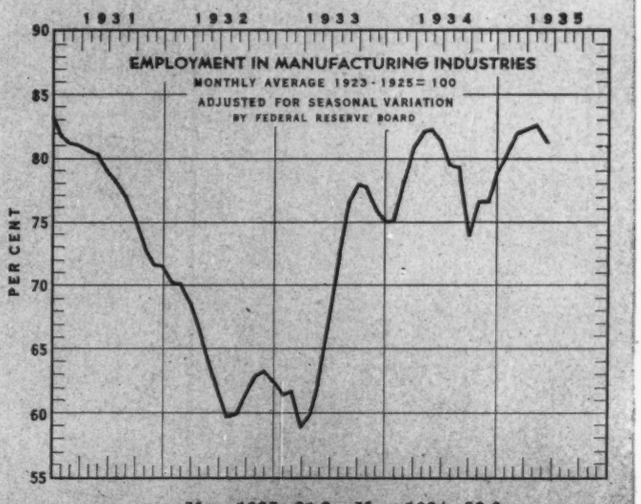


May 1935, 94.4—*May* 1934, 69.9



May 1935, 85—*May* 1934, 86

May 1935, 67.1—*May* 1934, 46.8



May 1935, 81.3—*May* 1934, 82.6

This name plate

gives capacity in horsepower according to the formula established by the American Gear Manufacturers Association. A nameplate of this character will be affixed as soon as possible to the products of the companies whose names are listed below:

An important announcement to users of SPEED REDUCERS

The American Gear Manufacturers Association has unanimously adopted as Recommended Practice rating formulas for determining the capacity of any standard helical or herringbone geared speed reducer or any heavy duty worm geared speed reducer. These Formulas are the result of several years of experimental work and mathematical research by a Committee of Engineers especially appointed for the purpose by the A. G. M. A.

Previously much confusion and lack of uniformity existed in the rating of speed reducers which was obviously detrimental to the interests of the purchaser. The A. G. M. A. Ratings now adopted solve this vital problem. They are simple to apply, and are equally applicable for normal or for severe service, it being necessary merely to apply the correct service factor as given in tables when selecting a speed reducer for any individual purpose.

IN YOUR OWN PROTECTION YOU SHOULD SPECIFY A.G.M.A. RATINGS FOR YOUR SPEED REDUCER REQUIREMENTS. Write any of the manufacturers whose names appear below:

THE CLEVELAND WORM & GEAR CO.
3249 E. 80th Street — Cleveland, Ohio

DE LAVAL STEAM TURBINE CO.
Trenton, New Jersey

THE FALK CORPORATION
Milwaukee, Wisconsin

FOOTE BROS. GEAR & MACHINE CO.
5301 So. Western Blvd. — Chicago, Illinois

FOOTE GEAR WORKS, INC.
1301 S. Cicero Avenue — Cicero, Illinois

THE HORSBURGH & SCOTT CO.
5114 Hamilton Ave. — Cleveland, Ohio

W. A. JONES FOUNDRY & MACHINE CO.
4401 W. Roosevelt Road — Chicago, Illinois

LINK-BELT COMPANY
910 S. Michigan Ave. — Chicago, Illinois

PACIFIC GEAR & TOOL WORKS, INC.
1035 Folsom Street — San Francisco, Calif.

PALMER-BEE COMPANY
Detroit, Michigan

PHILADELPHIA GEAR WORKS, INC.
Erie Ave. & G. Street — Philadelphia, Pa.

WATSON-FLAGG MACHINE CO.
Paterson, New Jersey

WESTERN GEAR WORKS
9th Ave. So. and King St. — Seattle, Wash.

WESTINGHOUSE ELECTRIC & MFG. CO.
Nuttall Works — Pittsburgh, Pa.

NOTEWORTHY PATENTS

SIMPLICITY and accessibility together with construction to produce tighter banding are features of a newly patented cigar banding mechanism. International Cigar Machinery Co. is assignee of the patent granted to Joseph A. Neumair. Cigar *C* shown in *Fig.* 1, is supported in grippers 12 carried by a pair of conveyor chains 11. The grippers are pivoted on pins 13 (drawing *Y*) and are inter-geared by gear segments 14, being normally pressed toward each other to grip the cigar by fingers 16.

At the banding station a stationary cam 17 engages roller 18 on arm 15 and locks the grippers, holding the cigar against displacement by extreme pressure from the band applying parts. Cigar bands *B* are stacked vertically in a magazine 20. Elements 21 have inwardly and downwardly inclined wedging surfaces extending from end walls 20, which serve to produce an endwise pressure on the opposite ends of the lower bands to arch the bands outwardly and downwardly from the stack to separate the central portions of the bands.

Suction arms 22 (drawing *X*) on a rotating turret 23 withdraws the bands one by one from the magazine. The turret is driven step by step by geneva wheel 29. Band *B* is folded about cigar *C* by folders 38 supported on arms 39 to slide 41 which imparts vertical movement to the folders through levers 39 to fold the band along the vertical sides of the cigar. Slide 41 is given vertical movement by link 42 connected to lever 43 pivoted on shaft 44 and carrying roller 45 engaging a cam on shaft 37. The lowermost position of the slide and the band folding parts carried thereby is indicated by the dotted lines in drawing *X*, *Fig.* 1.

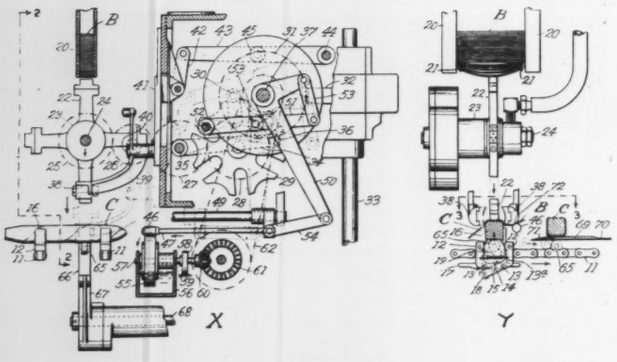


Fig. 1—*Co-ordinated mechanisms apply band to cigar and moisten the band ends which then are overlapped*

For moistening band *B*, there is provided a moistening element 46 in the form of a small roller of material such as felt. It is rotatably mounted on a reduced end position of carrier bar 47 which has reciprocating endwise motion derived from a bellcrank lever 50 actuated by lever 51 pivoted at 52 and carrying a roller 53 that engages with a cam on shaft 37.

To prevent rubbing of roller 46 as it passes the liquid supply device, a moistening wheel 55 supported in reservoir 56 is provided. This wheel is given a movement toward and away from the path of bar 47 by cam 58 resting on a stationary surface 59. Timing of cam 59 is such that the moisture supplying wheel 55 is moved into contact with the moistener roller 46 after the roller has been moved alongside the surface of wheel 55. As folders 38 move downwardly transversely of the vertical sides of the cigar to lay the band in U formation about the cigar, the band is forced into contact with the band moistening element 46, and during the continued movement of folders 38 the curved rear surface 72 of the folder (drawing *Y*) swings the moistener away from the cigar against the action of a spring.

After the band has been folded about three sides of the cigar by vertical movement of folders 38, the band ends are overlapped by folding means including a roller 65. This roller moves across the lower side of the cigar.

No. 1,992,760 identifies the patent.

BUNDLES of leaf springs are employed in an improved clutch to serve as the flexible connection between the driving disk and driven hub to absorb or diminish torsional vibration. Invented by Elmer V. J. Tower, this vibration dampener is covered by patent No. 1,993,126 which recently was granted. These bundles of leaf springs 34, *Fig.* 2, are arranged in pairs around the flange of the hub and are seated tightly in their respective hub sockets. Each pair projects into recesses formed in the out-

WHICH FRACTIONAL-HORSEPOWER MOTOR FOR APPLICATIONS LIKE THESE?

Left—For Washing Machines . . . incorporates lifetime lubrication, ready interchangeability, and "cushioned-power" mounting
Above—For Low Speed . . . Offers you unusual economies in installation and operating costs. Ready for direct-connection to your machines
Above—For Grinders . . . a sturdy, reliable motor with many qualifications for a tough job like this
The G-E Split-Phase Motor
• Type KH •
Above—For Fans and Blowers . . . A proved motor that will help your design set a new standard of quiet, carefree operation
Above—For Oil Burners . . . features "cushioned power"—pioneered by General Electric on oil-burner motors for flange mounting

Cushioned-power mounting; drip-proof end shields; simplified terminal connections these and many other advantages are available to you in this outstanding motor development

WHEREVER YOU need a compact, reliable small motor for applications that require constant speed, moderate starting torque, and dependable load-carrying ability, select the G-E Type KH.

This finely built motor is available in a wide variety of mechanical modifications (some of the types are illustrated above) which make it exactly matched to the needs of your design. Its ratings — from 1/40 to 1/4 hp. — offer you a wide range from which to choose wisely.

The Type KH motor is but one of a large variety of G-E fractional-horsepower motors for every purpose; this diversified line provides for all conditions of load and mounting encountered in modern products.

General Electric is always ready to work with you. G-E offers an unparalleled background of research and experience, gained through nearly a half century of manufacture of electric products — motors of all types and sizes, wire and cable, transformers — in brief, every electric product. General Electric, Schenectady, N. Y.

070-89

GENERAL ELECTRIC

For SEVERE RADIAL and SHOCK LOADS

PRECISION ROLLER BEARINGS afford—for extreme load conditions—the following outstanding advantages . . . Solid, cylindrical rollers, held to infinitesimal limits of accuracy, provide larger steady load and shock capacity than any other single-row bearing, together with a temporary overload capacity of 50% . . . Short roller construction affords ideal load distribution and greater wear resistance . . . Extruded bronze, machined and balanced, heavy-duty retainer is land-riding, relieving the rolling elements of its weight . . . Extreme refinement of design and finish gives a lower coefficient of friction under severe load than any other type of bearing and permits speeds up to 35,000 R.P.M. . . . PRECISION ROLLER BEARINGS interchange in size with all standard ball bearings . . . Write for the catalog. Let our engineers work with you. . . . . .

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP. STAMFORD, CONN., U. S. A.

ward portion of the two disk plates 36.

During the time the engine is driving the clutch disk, one element of each pair of spring bundles is being flexed by the turning power of the disk through contact of the flaring wall 40 with the respective spring bundle elements. When the vehicle coasts, the other set of elements come into operation with corresponding relation to the opposite flare or curved walls of the plate recess. With this arrangement a certain amount of relative movement is permitted between the driving disk and the driven hub, one set of springs operating to receive and dampen vibration impulses from the driving member and the other set to receive and dampen vibration from the driven member.

The purpose of rollers 50 is to relay the pressure from one spring pack to the other. A T-

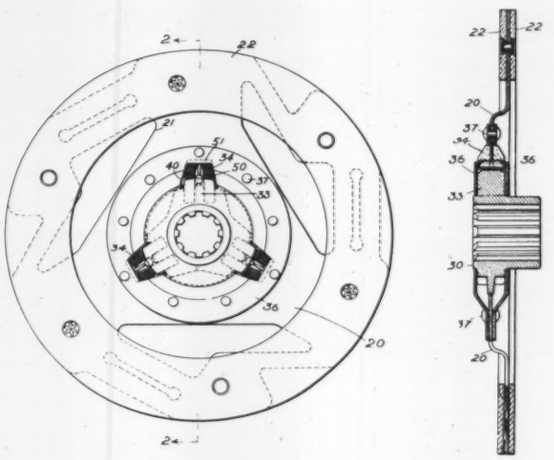


Fig. 2—Torsional vibration is absorbed by bundles of springs between driving disk and driven hub

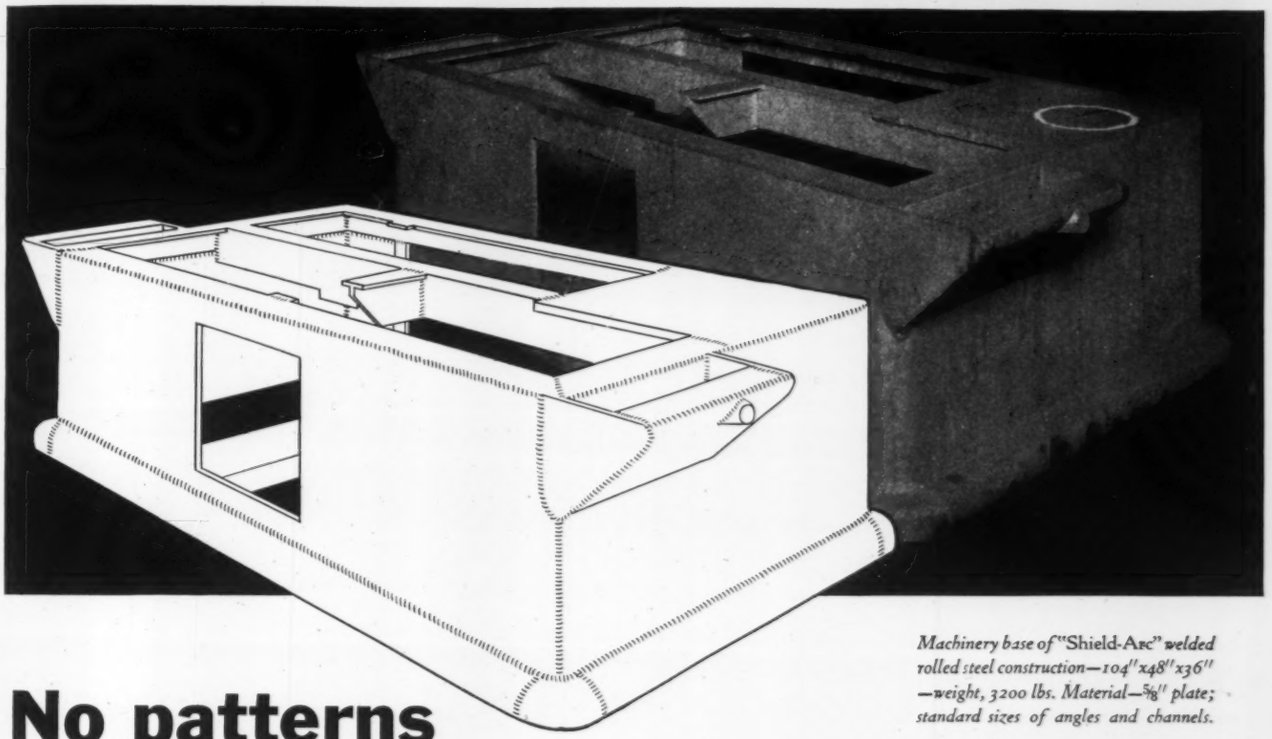
shaped projection 51 is straddle-mounted at the outer ends of the bundle pairs so that the inwardly projecting leg also assists in holding the rollers in proper position when under the influence of centrifugal force and aids in preventing undue wedging action of the rollers.

Russell Mfg. Co. is assignee of the patent.

CENTRIFUGAL force is used effectively in the operation of a speed-controlled shaft coupling, invented by Richard Lang, Ravensburg, Germany, and covered by U. S. patent No. 1,999,-364. The device, *Fig.* 3, affords a constant rigid driving connection between a motor-driven shaft and the shaft driving an auxiliary device during normal period of operation, but allows the relative position of both shafts to each other to change when the speed of rotation differs. This alteration in the rotational position of the shafts takes place when driving force is at a minimum.

Numerals 10 to 20 designate the two shafts. Fixed to shaft 10 is a sleeve 11 which carries

"Shield-Arc" WELDED



Machinery base of "Shield-Arc" welded rolled steel construction—104" x 48" x 36" —weight, 3200 lbs. Material—⅝" plate; standard sizes of angles and channels.

No patterns required . .

THE money that would have gone for patterns paid the entire cost of the completed base. Though this base weighs half as much as an ordinary casting it is stronger and more rigid. It was built complete in less time than would have been required to make patterns.

Now . . . figure the savings you could put in your pocket by using *"Shield-Arc"* rolled steel construction. Remember . . . no patterns are required . . . drafting is simplified . . . inventory is reduced . . . changes in design cause no delay in production . . . all these advantages contribute to your profit. But the necessary element is the *"Shield-Arc"* welder . . . guaranteed three ways to produce more welding per dollar. Find out now what this guarantee means to you. Ask The Lincoln Electric Company, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

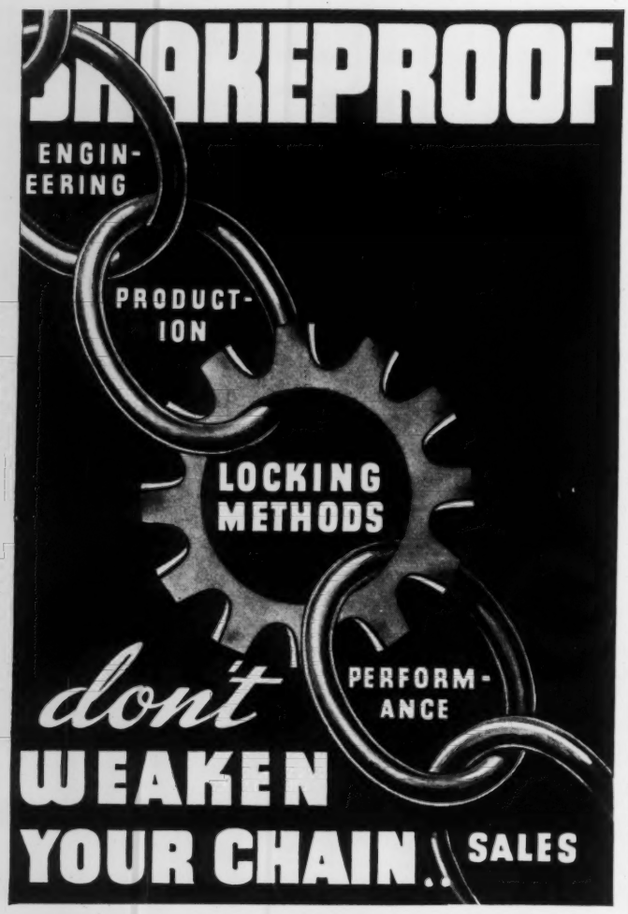
W-142

LAD "I see where an archeologist says that Europe once touched America."

POP "More than *once*, Lad, more than once. And let that be a lesson to you not to get mixed up with welding machines that give only promises when you know that the *'Shield-Arc'* is guaranteed three ways to deliver the goods on welding."

LINCOLN

"SHIELD-ARC" WELDERS



FAULTY lock washers, the kind that loosen under vibration, can seriously affect the success of any product. Don't handicap yourself by overlooking this vital factor—play safe by using Shakeproof to hold every connection absolutely tight. The twisted teeth of this positive-action lock washer bite into both the nut and work surfaces and, as vibration increases, they dig in deeper—never permitting the nut to loosen or back off. Go over your product immediately, study each connection carefully and, at least, provide Shakeproof protection for those parts that are most likely to be exposed to vibration. Free testing samples are gladly furnished—write for yours today!

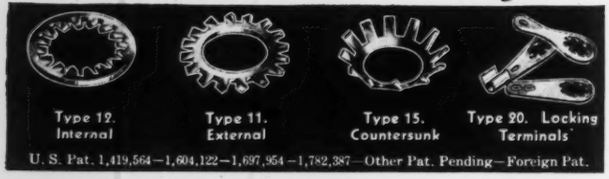
NEW CATALOG

Just off the press—our new 1935 catalog tells you how to solve your locking problems. Also illustrates and explains other patented Shakeproof products—a truly valuable book—send for your free copy today!

SHAKEPROOF
Lock Washer Company

Distributors of Shakeproof Products
Manufactured by Illinois Tool Works

2551 N. Keeler Ave. Chicago, Ill.



U. S. Pat. 1,419,564—1,604,122—1,697,954—1,782,387—Other Pat. Pending—Foreign Pat.

member 14 journaled on bolts 13. Members 24 are journaled on bolts 23 fixed to disk 21 which is made integral with shaft 20. Members 34 journaled on bolts 33 are fixed to elements 32 adapted to slide inside of sleeve 11 without being fastened to parts of either shaft 10 or 20. Weights 41 and 42 are inserted between members 14 and 34 and members 24 and 34, respectively. These weights move radially under the influence of centrifugal force against the counter action of springs 35 when the coupling mechanism rotates. Side faces of the weights are sloped, but in different directions. As speed of rotation of the shafts increases, weights 41 and 42 move outwardly from their neutral positions shown in drawings *A* and *C*, *Fig.* 3, into another position depicted in drawings *B* and *D*. By this outward movement

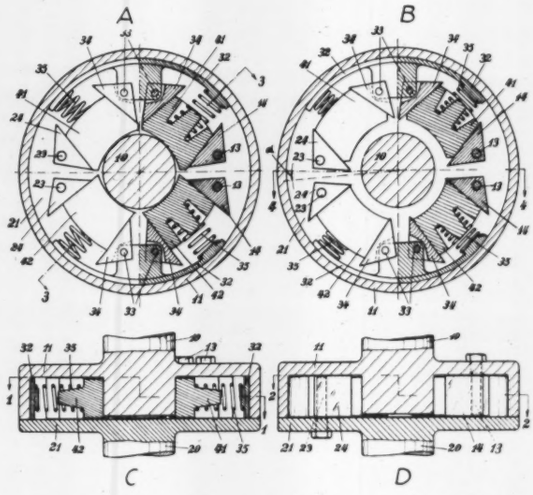
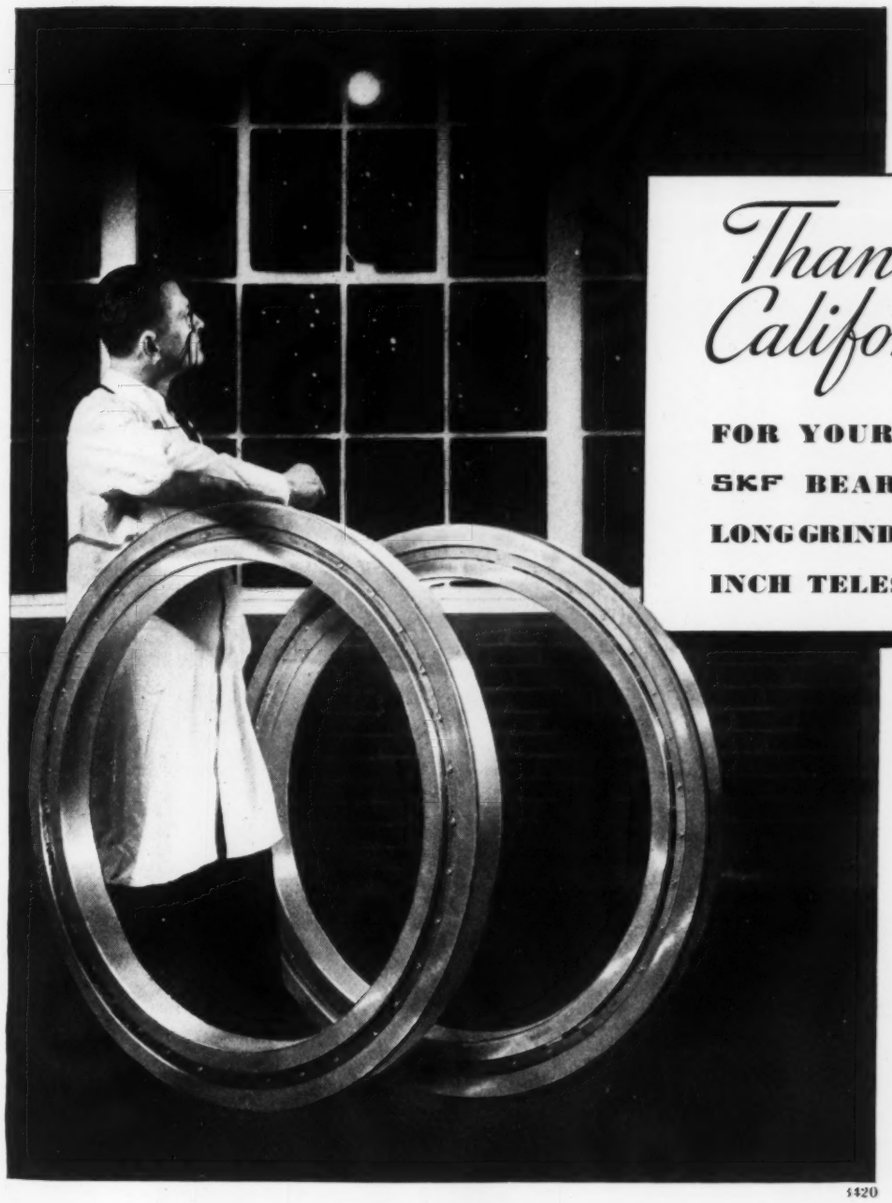


Fig. 3—Effect of centrifugal force on weights changes relative position of shafts

the relative position of shafts 10 and 20 in the sense of rotation is changed slightly as indicated by angle α in *B*.

Weights 41 are heavier than weights 42, because the former need to force their way outward between members 14 and 34 and members 24 and 34, respectively, whereas the outward path for weights 42 is open. Inclination of the sloping side faces of the weights is so chosen that the angle of friction is not surpassed, which means that the weights together with the intermediate members form a rigid transmitting construction that cannot yield as long as there is sufficient force transmitted through the coupling. The weights, however, are allowed to alter their radial position on a change of speed of rotation in the interval when the driving force is at a minimum, thereby changing the relative position of the shafts.

Maybach-Motorenbau G.m.b.H., Friedrichshafen, Germany, is assignee to the patent.



Thank You... California Tech

FOR YOUR SELECTION OF SKF BEARINGS FOR THE LONG GRIND OF THE NEW 200-INCH TELESCOPE MIRROR!

Two giant SKF Bearings, produced for California Institute of Technology to be used on the grinding table on which the 200-inch mirror is to go through the five-year finishing process. They are the most accurate giant anti-friction bearings ever produced. BELOW: The giant mirror after casting by Corning Glass Works, Corning, N.Y.

4420

● You are planning, California Tech, the longest grind in the world . . . a five-year job of grinding the famous 200-inch telescope mirror now cooling at Corning, N.Y., to a new high in accuracy. It will be within one millionth of an inch from the true!

Lay minds are staggered by mammoth mechanical or astronomical things that are so uncannily close to perfection. But to SKF men all over the world, trained to thinking in terms of precision manufacturing, news of your selection of SKF Bearings for this delicate grinding operation brought a definite feeling of pride.

Let us tell you about the two giant SKF Bearings that have been delivered to you. They are almost as tall as a man. They are the world's closest twins. The difference in the diameters of the two bearings is exactly three ten thousandths of an inch. The roundness of the bearings is within half a human hair's breadth of sheer perfection.

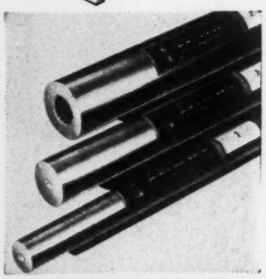
Nowhere else on earth . . . and quite likely nowhere on the millions of planets that will be scanned through the great telescope, will giant anti-friction bearings be found that are comparable in accuracy with these.

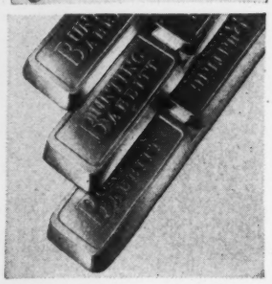
SKF
Puts the Right Bearing in the Right Place

SKF
BALL & ROLLER BEARINGS

SKF Industries Inc., Front Street and Erie Avenue, Philadelphia, Pa.

AIDS TO INDUSTRY





● There is no bushing or bearing problem—not even an annoyance from that source—in thousands of plants in all industries throughout the world where exists in desk drawer, drafting room or shop a list of Bunting Bronze Standardized Bearings. Here is every bushing or bearing required in practically all machinery production and maintenance—over 500 different sizes—instantly available almost everywhere in any quantity great or small, made of a special and superior bronze alloy developed in our own research laboratories for the great mass of usual applications. Write for this list—we will gladly send you as many copies as you require. One of these lists is practically the same as a stock of more than 5,000,000 bronze bearings of over 500 different sizes from $\frac{3}{8} \times \frac{1}{4} \times 1\frac{1}{4}$ to $4\frac{1}{2} \times 4 \times 7$.

The next time you buy bronze bars ask for the Bunting machined and centered 13" bar. You will save in labor alone far more than the cost of the bar, if you have been using rough cast bars. 121 stock sizes at all leading supply wholesalers.

Haven't you often wanted a better, more easily handled industrial Babbitt? Here it is. Bunting Babbitt is the amazing anti-friction metal developed by a great staff of metallurgists for industrial use. Ask your supply dealer.

THE BUNTING BRASS & BRONZE COMPANY, TOLEDO, OHIO

Branches and Warehouses in All Principal Cities

BUNTING Quality

BRONZE BUSHINGS • BEARINGS

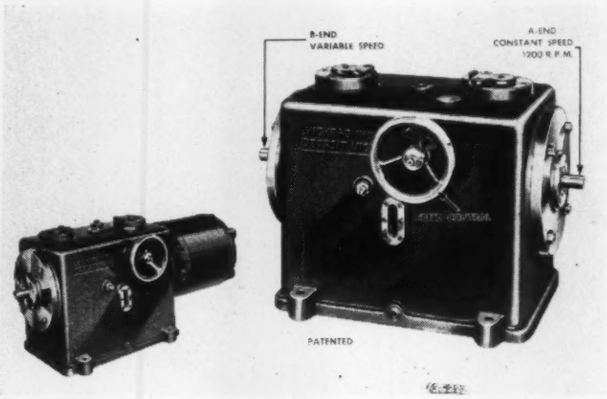
MACHINED AND CENTERED BRONZE BARS

ANTI-FRICTION METAL

New Materials and Parts

Hydraulic Units Provide Variable Speed

ANY desired speed between 5 and 750 revolutions per minute is secured accurately and smoothly by simply turning a handwheel which varies stroke and delivery of a multiple piston type pump on the variable speed transmission of Vickers Inc., 1400 Oakman boulevard, Detroit. Additional adjustments permit speeds up to 2500 RPM. Hydraulic, mechanical or electrical remote control can be substituted for the manual control shown in the accompanying illustration.



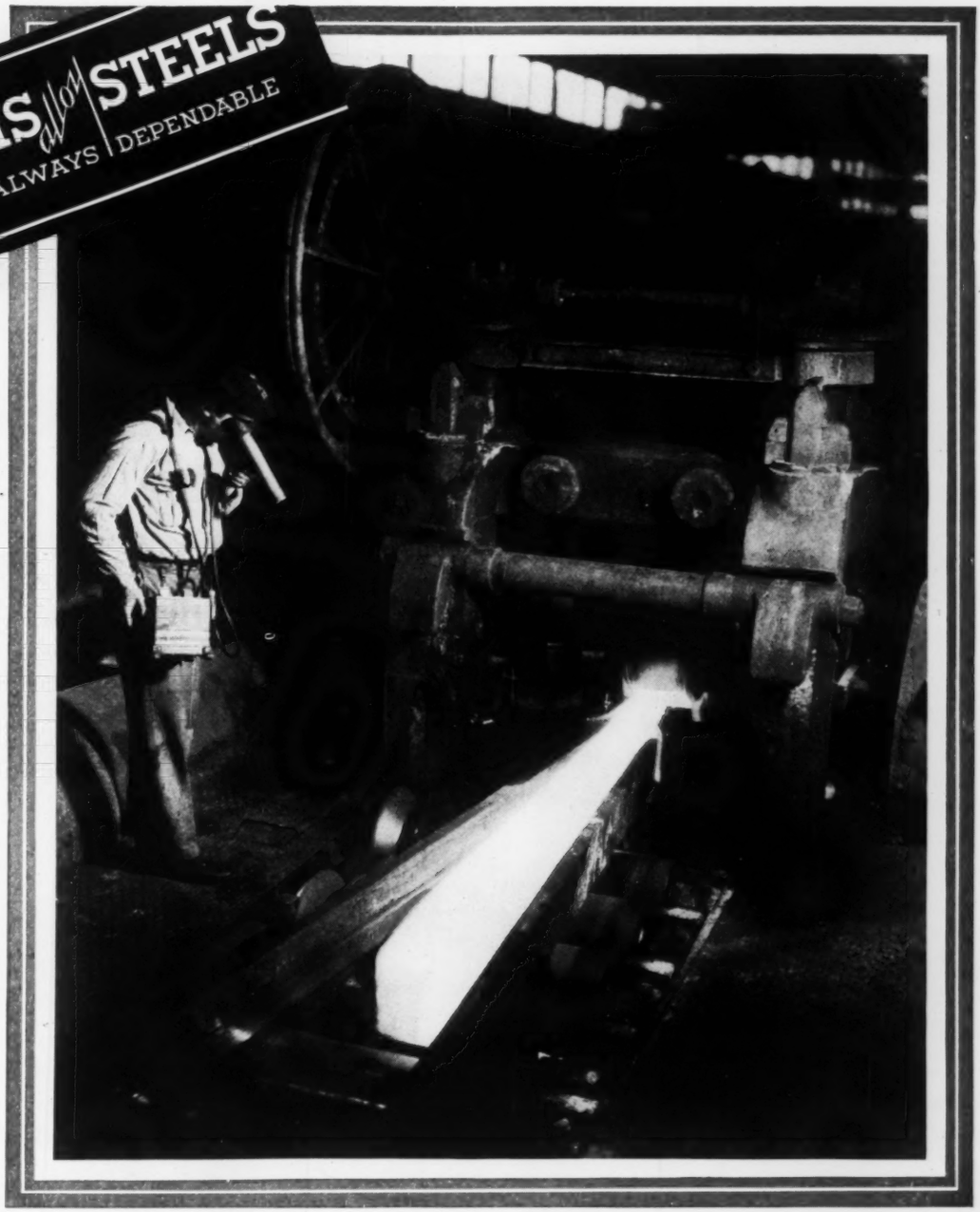
Infinitely variable speed may be obtained with recently introduced hydraulic transmission

Rotation in either direction can be provided for either end of the unit, and this can later be changed on the job without additional parts. Units can also be provided with mechanism for instantaneous change of direction. The unit is totally enclosed, making the transmission unaffected by moisture or dirt in the atmosphere. A direct-connected 1200 RPM motor drives the transmission. Units in stock have maximum output of 6 horsepower continuous duty at 1000 pounds per square inch and 7½ horsepower intermittent service at 1250 pounds per square inch. Larger units will be made available later.

Drum Type Switch Is Small

SMALL size, a simple sturdy mechanism and high capacity rating are features of a new drum type reversing switch developed by Cutler-Hammer Inc., 429 North Twelfth street, Milwaukee. The switch, known as bulletin 9441, type V1, is of the across-the-line type, with "Twin-

ILLINOIS alloy STEELS
ALWAYS DEPENDABLE



SCIENCE SAYS "*THUMBS UP*"

● There goes a billet of Illinois Alloy Steel, two seconds out of the pre-heating furnace, entering the first stand of rolls. What's its temperature? The pyrometer will tell. For every billet must enter the mill at a precise temperature. Heat and speed are controlled exactly in this mill to assure the physical qualities required in the finished steel.

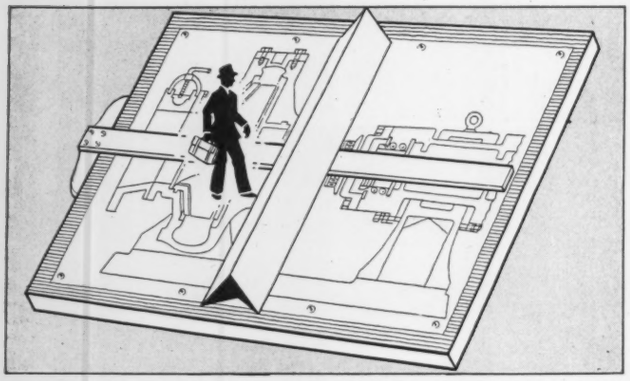
Part of the job is in the heating furnace. There modern design and modern control assure uniform heating throughout every inch of the billet. Then, in the mill itself, a constant watching of rolling speeds and repeated checking of temperatures brings the finished stock out on to the cooling bed in accordance with the dictates of the metallurgist.

Illinois' alloy mills have been modernized in every particular. We know of no other mill practice which so safeguards the mechanics of rolling or the quality of the steel it produces.

ILLINOIS STEEL COMPANY
208 SOUTH LA SALLE STREET, CHICAGO, ILLINOIS

United States Steel Corporation Subsidiary

THE UNDERWRITERS *Balked* AT THE PACKING POINT*



. . . WHEN THE PACKING LET THE ROD MOVE FREELY, IT ALSO LET OIL THROUGH. *Then they called in* GRATON & KNIGHT

One thirty-second of an inch of leather, tight enough to keep out the oil . . . flexible enough to permit the rod to operate. It *had* to operate 100% efficiently—*otherwise* the underwriters would not pass it.

Until Graton & Knight came into the picture, it seemed to be a question of re-designing—at extra cost and with the probability that nothing better could be created.

But Graton & Knight's knack of producing a satisfactory packing for a ticklish job—combined with a special oil and heat-resisting leather—saved the day and saved the product for a profitable market.

STOPPED AT THE PACKING POINT?

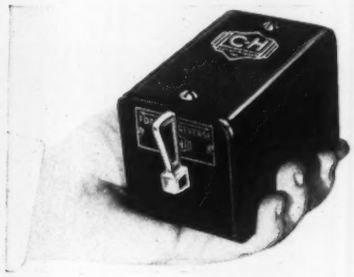
Let Graton & Knight show you where and how the particular problem at your "Packing Point" can be solved. Special packing leathers, laboratory tested at the **HOME OF RESEARCH** by Graton & Knight Engineers, are ready to meet such conditions as heat, water, air, semi-corrosive liquids, etc. Prove the superiority of leather for packings to your own satisfaction by writing or wiring for Graton & Knight Leather Packings.

***THE "PACKING POINT"** is the point in the design of a machine where the problem of packing enters—the point where we suggest you consult Graton & Knight.

"Creating Success at the Packing Point"

break" contacts and molded arc barriers to give it a high rating and long life. It can be furnished in either a standard enclosure or as a skeleton drum with mounting plate for building into machines.

All arcing parts of the switch, shown herewith, are designed to be easily renewed. Movable contacts are removable without the use of any tools. The stationary contacts are assembled into a molded base so that when they require renewal, the entire base is replaced by simply removing three screws.



Movable contacts in drum type reversing switch are removable without the use of any tools

The drum switch is applicable to almost any type of single phase, polyphase or direct current motor. It can also be used as a three pole, double throw switch by removing the jumpers. Ratings are:—for single phase, 1 horsepower, 110 volts, 1½ horsepower, 220 volts—for polyphase, 1½ horsepower, 110 volts, 2 horsepower, 220, 440 or 550 volts—for direct current 1 horsepower, 115 or 230 volts.

Designs Refrigeration Motors

SQUIRREL cage normal torque and high torque motors in a new line especially designed for refrigeration and air-conditioning applications have been introduced by Century Electric Co., St. Louis. These motors, shown herewith, are designed to give a composite performance of torque, efficiency, power factor and quiet operation which is best suited to this type of equipment, including the latest designs of Freon compressors.

Refrigeration and air-conditioning motors are designed for quiet operation

The construction includes cast frame and end brackets, ample sized shafts and bearings and

"IF I WERE A BEARING BUYER

Here are some of the things I would want to know about the Bearing Manufacturer"

"If I were buying anti-friction bearings—or any other part as vital to the efficiency, dependability and endurance of my product—I would want to satisfy myself on the following points before selecting any make.

"**FIRST:** Has the bearing manufacturer had sufficient experience in making and applying bearings to enable him to provide the best solution to my particular problem?

"**SECOND:** Is the bearing manufacturer's engineering personnel trained and experienced enough to give me authoritative advice on general machine design as well as bearing application?

"**THIRD:** Does the bearing manufacturer have a competent service organization to take care of bearing emergencies in my factory and in the field?

"**FOURTH:** Is the capacity of the bearing manufacturer's plant large enough to take care of my requirements promptly and completely during production peaks?

"**FIFTH:** Is the bearing manufacturer in a strong financial position? Does he have a reputation for backing up his product under all circumstances?

"**SIXTH:** Will this particular make of bearing be acceptable to users of my product? Will it add prestige and sales value?

"**SEVENTH:** Is this particular make of bearing strong in my industry? Is it well regarded by other leading manufacturers of equipment similar to mine?

"The bearing manufacturer who could answer "yes" to all of these questions—and back it up with proof—would stand the best chance of getting my business."*

***THE TIMKEN ROLLER BEARING COMPANY • CANTON, OHIO**

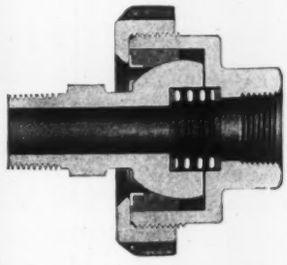
invites the bearing buyer's most searching investigation at all times

COPYRIGHT 1935, BY THE TIMKEN ROLLER BEARING COMPANY

well anchored field and rotor cores. Electrical stability is provided through the use of electrolytic copper bars and end rings so joined as to form an homogeneous high conducting joint. These motors are available in sleeve and ball bearing designs as required and are available in sizes 600 horsepower and smaller.

Swivel Joints Are Improved

IMPROVED swivel joints for use on platen presses, tire and tube molds, and similar machinery to connect piping between moving parts have been brought out by Barco Mfg. Co., Chicago, Ill. As can be seen from the accompanying illustration, the new joint now incorporates



Piping connections may be made with improved swivel joints

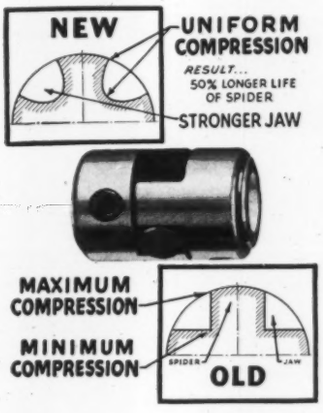
a metal washer or bearing at each end of the spring, thus eliminating the spring wear on the two parts of the joint, viz: the ball and casing. This improvement not only prolongs the life of the major portions of the joint, but also greatly reduces the possibility of spring breakage.

Coupling Has Unique Jaw Surfaces

INSTEAD of using the conventional parallel jaw surfaces where the outer edges of the jaws bear on the cushioning spider, causing premature wearing at the ends, the new L-R type "IA" coupling being manufactured by Lovejoy Tool Works, 5018 West Lake street, Chicago, has convex jaw surfaces that exert a rolling pressure when bearing on the spider arms. Utilizing the variation of compressibility with the thickness depending upon the resilient cushioning materials used, the convex surfaces proportion the spider arms so that the compression is substantially uniform, regardless of the extent to which each portion is compressed, thus each portion of the arm bears an equal share of the load. The jaw faces of the coupling approach each other with uniform wear over the entire surface of the spider arm in such a manner as to render it useful as a cushioning agent for the metal jaws until the spider is practically worn out.

Other features of the new coupling, shown herewith, are: Three-part construction (two

metal flanges and a one-piece spider) simplifies assembly; the spider member has sufficient resilience to safeguard the connected machines against shocks, overloads and misalignments;

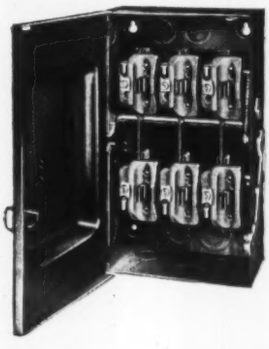


Uniform compression throughout the cushioning spider is developed in redesigned coupling

and quietness of operation. The couplings are made in standard sizes with bores from ¼ to 3 inches (½ to 200 horsepower at 1750 revolutions per minute).

Switches Are Redesigned

IMPORTANT revisions have been made in the line of type "A" industrial safety switches being manufactured by Colt's Patent Fire Arms Mfg. Co., Hartford, Conn. The 575-volt switches are now equipped with the "Quad-break" switching mechanism which provides four current rupture points in each leg of the circuit, thereby reducing the arcing tendency to a minimum and prolonging the life of the switch. The mechanism has been improved and simplified. With the unit blocks redesigned for greater accessibility of contacts, a complete unit block can be removed from the cabinet without disturbing the rest of the switch. The blocks are more rugged than before and have been designed to stand up under severe overloads.



Four current rupturing points in each leg of the circuit are provided in industrial safety switches

The 250-volt switches make use of the "Dual-Break" switching mechanism which breaks the circuit at two points in each leg. The switching

SHAFER

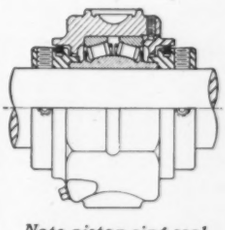
roller bearing

HANGER BOX

● For modernizing power transmission drives—fits all standard 4-point hanger frames. Extra power-saving performance is the result of the exclusive Shafer CONCAVE roller design that combines generous radial-thrust roller bearing capacity and free-rolling self-alignment within the bearing itself.

Compensation for shaft deflection and mis-alignment is automatic, without any premium in size or weight.

Available in a full range of sizes—Hanger boxes, Pillow blocks, Flange Units, Cartridge Units, Take-up Units, Conveyor rolls, Radial-thrust Roller Bearings.



Note piston ring seal and double-end square □ drive collars

Catalog 12 gives complete descriptions. Write for your copy.

SHAFER
BEARING CORPORATION
6513 WEST GRAND AVENUE • CHICAGO, ILL.

DEPENDABLE PUMPS

--in a variety of types and sizes

—for coolant—circulation hydraulic systems, etc.

Tell us your problem—we'll gladly make a recommendation — either a stock or a special pump. Brown & Sharpe Mfg. Co., Providence, R. I.

Brown & Sharpe Pumps
Geared — Vane — Centrifugal

PULLMORE CLUTCHES ON FIRE TRUCKS

Reliability is the outstanding requirement for clutches used in fire fighting equipment. Next comes compactness, adaptability to design, smoothness of operation. These qualities are all present in Pullmore Clutches. That is why a No. 5 Double-Type Pullmore Clutch, running in oil, is used in the raising and lowering mechanism of Aerial Ladder Trucks made by Mack International Motor Truck Corp., one of which is shown above. This company writes "The No. 5 Double-Type Pullmore Clutches you have been furnishing us have been working out very nicely . . . ". Pullmore Clutches are made in Single and Double Types, for operation in oil or dry, in capacities from 1 H.P. to 60 H.P., at 500 r.p.m. They are giving complete satisfaction in a wide variety of machines and equipment. Investigate! ***Write today for the Pullmore catalog.***

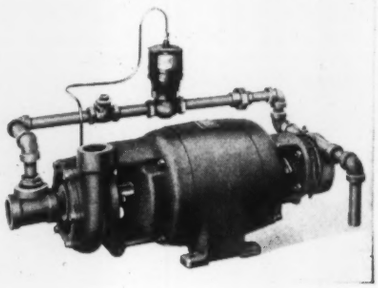
ROCKFORD DRILLING MACHINE CO.
304 Catherine Street, Rockford, Illinois
Sold by MORSE CHAIN CO., Ithaca, N. Y.
With offices in principal cities

mechanism itself has been improved to keep wear of moving parts at a minimum.

Type "A" cabinets have been made narrower and the new cast metal handles have been placed closer to the side of the cabinet. Close banking of switches is further facilitated by the newly designed front cover which is hinged on the front instead of the side. A new cover catch with independent spring has been located at the top of the cabinet instead of on the cover surface.

Primes Pump Automatically

AUTOMATIC priming of pumps has been achieved by Worthington Pump & Machinery Corp., Harrison, N. J., by the development of the Hytor, a positive primer placed on the same shaft with the motor and pump. The only requirement for this operation is a reasonably tight suction line. When the pump, shown herewith, is primed, a pressure-operated cutout automatically unloads the Hytor. There is no recirculation of water or floats, nor are there valves that must be set.



Automatic priming is provided for operation of recently introduced pumps

The unit is compact, neat and modern in appearance, with a splash-proof motor, all being included on a symmetrical mounting. The pump is available for single or polyphase 50 or 60 cycle alternating current as well as for direct current operation.

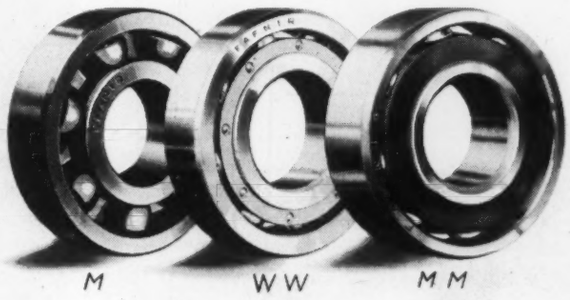
Offers Precision Ball Bearings

THREE new types of extra precision ball bearings designed for high speed use where extreme accuracy is required have been made available by Fafnir Bearing Co., New Britain, Conn. The bearings, shown herewith, are of the single row radial type with both rings and balls of high carbon chrome steel. Deep groove races afford maximum thrust capacity and cushioning support under shock loads.

The "M Type" bearings, manufactured to especially high standards of accuracy, are now available in all standard sizes for light, medium or heavy loads. Bearings with equally close manufacturing tolerances, but equipped with a

special machined and ring-piloted bronze retainer to assure concentricity in operation, are also offered in a wide range of sizes. This series of bearings is known as the "WW Type," having been developed particularly to meet the rigorous service conditions of high speed woodworking machinery.

The "MM Type" bearings, developed for high

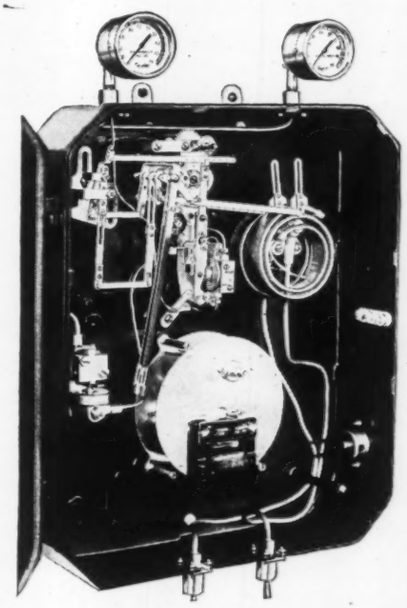


New types of extra precision ball bearings are especially designed for high speed use

speed machine applications and other special fields, are made with even greater accuracy than the "M Type" and may be obtained with special composition retainers, instead of steel or bronze, to assure the lightness in retainer weight that aids exact running balance.

Unit Controls Variables

CONTROL of temperature, pressure, rate of flow or liquid level in a predetermined relation to some other temperature, pressure, rate of flow or liquid level is possible with the new reset controller of Taylor Instrument Cos.,

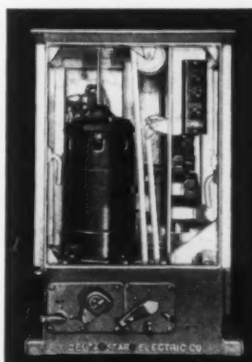


Controller can be applied where a fixed differential must be maintained between two variables, one of which is under control

Record Breaking Switches

POWERED BY MASTER MOTORS

This is just one terminal of the mammoth 3 pole, 287,000 volt Delta Star disconnect switches to be used on record breaking Boulder Dam. Sixteen such 15-ton, $10,000 switches will be installed on the 240,000 KW, 270 mile transmission line from Boulder Dam to Los Angeles. Specially constructed reversible Master Guaranteed Motors with integrally built multi-disc, Uni-brakes, operate these switches. Where absolute dependability is required in a motor designed to your particular needs, you too should let Master Engineers help you select the motor best suited to your requirements.

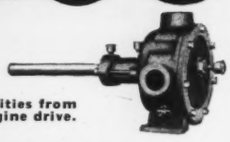


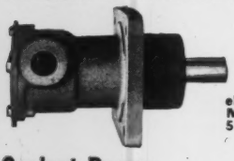
THE MASTER ELECTRIC COMPANY
DAYTON OHIO U S A

VIKING

Standard Rotary

For handling any grit-free liquid of any viscosity from water to molasses . . . with efficiency and economy . . . use the Viking Rotary Pump. "Just Two Moving Parts." Capacities from 1/5 to 1,050 G.P.M. Electric motor, belt or gas engine drive.



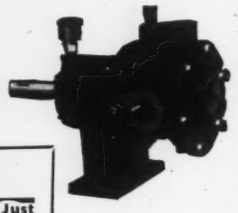


Hydraulic Oil Pressure

For the actuation of machine tool movements and the operation of hydraulic lifts and elevators use the Viking Hydraulic Oil Pump. Made of laboratory-tested metals in capacities of 5 to 45 G.P.M.

Coolant Pumps

For machine tool cooling purposes use the Viking Coolant Pump. Capacities of 5, 10, 15, 20 and 35 G.P.M. Ports are tapped and plugged to permit changing the direction of rotation . . . 4 position casing mounting. Built-in relief rotor to act as relief valve when the oil line is shut off.



The Viking Principle

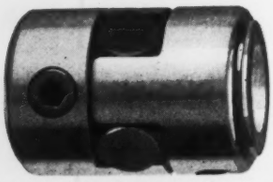
"Gear Within A Gear . . . Just Two Moving Parts" . . . insures low power requirements . . . minimum friction and wear . . . and long life. Tested in nearly 500,000 Viking Pumps . . . proved by nearly a quarter century of experience.

Write for FREE Folder and Prices

VIKING PUMP COMPANY
Cedar Falls, Iowa

Rotary Pumps

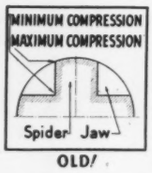
NEW L-R TYPE "IA"
FLEXIBLE COUPLING



NEW!

U. S. and Foreign Patents Pending

CONVEX SURFACE DESIGN LOWERS MAINTENANCE COSTS



OLD!

Compare these sketches! Note how L-R Convex Surface Construction strengthens jaws and due to *rolling* pressure when power load bears on cushion arms, life of resilient spider is increased fully 50%. Not only does this new design give uniform compression but it saves money by reducing maintenance time. You can depend upon L-R Flexible Couplings for highest efficiency, lowest operating costs and dependability. Type "IA" Couplings are available with bores from ¼" to 3" (1/12 H.P. to 200 H.P. at 1750 R.P.M.)—other types up to 10 in. shaft. dia.

SEND FOR SAMPLE

You be the judge—*try an L-R Flexible Coupling at our expense.* Just send shaft dia., H.P. and R.P.M. and we'll send one for testing—or, write for engineering data and literature.

LOVEJOY TOOL WORKS

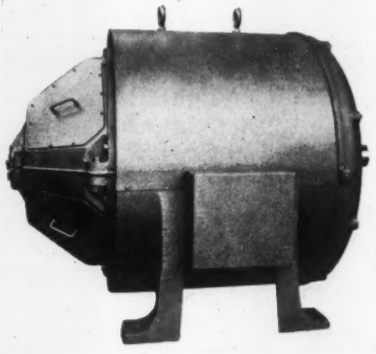
5018 WEST LAKE ST. **CHICAGO, ILL.**

Rochester, N. Y. The controller, shown herewith, can be used on all applications where a fixed differential must be maintained between two variables, one of which is under control; or where it is desirable to change the control point of a process in accordance with a predetermined ratio to a secondary process or condition.

The unit employs one complete "Fulscope" control system and, in addition, an extra tube system, pressure spring or manometer, depending on the application. The "Fulscope" mechanism and the second actuating or "resetting" mechanism are separate, yet so interconnected by linkage that any changes which occur in the "resetting" system are transferred to the "Fulscope" mechanism as control point adjustments. Both the adjusting and the controlled conditions are recorded.

Large Motor Is Arc Welded

ARC WELDED construction was employed in the fabrication of what is believed to be the world's largest direct current fully enclosed fan cooled motor by Reliance Electric & Engineering Co., Cleveland. This large motor, shown in the accompanying illustration, is 7 feet 6 inches long and weighs 14,000 pounds. It is rated at 125 horsepower at 300 revolutions per minute and is to be used to operate a steel mill



Rolled steel, cut and formed into two semi-circular sections is used in construction of unusually large motor

pickling machine. 200 horsepower can be secured if the motor is wound for 400 R.P.M.

The frame of this motor is made of 2-inch rolled steel, cut and formed into two semi-circular sections, with holes punched for the channels. These channels, made of ¼-inch steel plate, are then welded to the frame all the way around, thus making them air tight. Besides keeping dirt away from the windings, the channels provide a means of cooling the motor as the air inside the motor circulates through the channels and an outer fan blows cooling air over the external surfaces. The motor is supported on two sets of cast steel feet, welded directly to the motor frame by shielded arc welding equipment.

Utilizing Hydraulics for Indexing

(*Continued from Page* 26)

level to the right of the loading station, *Fig.* 1, sets the fluid motor in motion to carry out the indexing cycle. As the operator steps on the foot pedal which is connected to lever *B*, *Fig.* 2, lock bolt *C* is withdrawn from its guide bushing in the table which now is free to be rotated. As the bolt recedes it carries with it an integral plate *D* which operates limit switch *E*. A solenoid is energized to open valve *N* and allow oil pressure to actuate the fluid motor *F*.

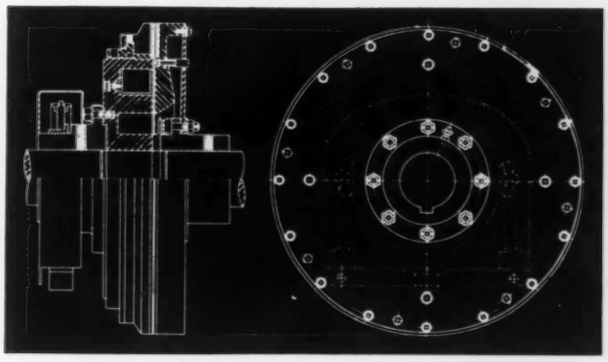
When the table has revolved seventy-two degrees, dog *G* on the underside of the table comes into contact with a plunger on valve *H* and stops the fluid motor. Subsequently, lock bolt *C* snaps into engagement with a guide bushing in the table, operating limit switch *E* through plate *D* in a direction opposite to that at the beginning of the index. This energizes another solenoid to actuate valve *O* and consequently advance the four tool heads, *Fig.* 1, into working position.

The tool heads, three carrying boring tools and the last a reaming tool, all for the purpose of machining the oil pump hole in each cylinder block, are connected to piston rods *J* of cylinders *R*, *Fig.* 2. These tool slides, at the completion of their downward course, actuate limit switches *P* which energize a solenoid to trip valve *O*, thus reversing the hydraulic circuit to cylinders *R* and withdrawing the tools from the cylinder blocks.

Hydraulic pressure for both the fluid motor and the cylinders that control the tool heads is provided by a combination pump *K* driven by a ten horsepower motor *S*. This pump is made up of two units *L* and *M*, the former delivering a large volume of oil at low pressure for rapid traverse of the tools, and unit *M* furnishing low volume at high pressure for the indexing operation and tool feed during the machining interval.

Based on a feeding time of thirty-three seconds, this machine has an operating cycle of approximately forty seconds for a gross production of ninety cylinder blocks per hour. Pumps, controls and the fluid motor were built by Vickers Inc. The 95-inch table is carried on a Bantam ball thrust bearing.

Use of hydraulics combined with electrical devices, in design of machinery continues to grow and with virtually each succeeding application new ideas suggest themselves. The fluid motor with its adaptability to perform an indexing operation efficiently and simply adds another laurel to the hydraulic principle and its place in mechanical engineering.



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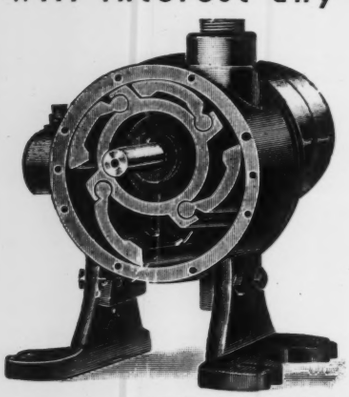

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Avoid Waste of Material in Parts Design!

(*Continued from Page* 25)

holes and also of the stress concentration due to these holes.

Assume the pins to be made of the same SAE 1030 steel. Since the elastic limit in shear is 26,000 pounds per square inch and with two pins there are four shearing areas, therefore the cross-sectional area of the pins should

$$A_s = (1.026 \times 39{,}900)/(26{,}000 \times 4) = 0.394 \text{ sq. in.}$$

$$d_s = \sqrt{0.394/0.7854} = 0.501 \text{ or } \tfrac{1}{2} \text{ in.}$$

Estimating the stress concentration factor at first as $k' = 1.5$, the diameter d_2 *Fig.* 16, can be computed from the equation

$$0.7854\, d_2^2 - 0.5 d_2 = 1.026 \times 1.5$$

which gives $d_2 = 1.761$ or, in this case rounding up, $d_2 = 1\text{-}13/16$ inches .

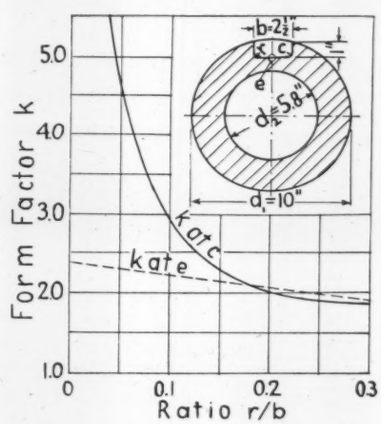


Fig. 17—*Keyways have a stress concentration effect noticeable particularly at end of keyway*

Now the stress concentration can be computed more accurately. The form factor, using *Fig.* 2 (M. D. June, p. 16) but instead of the ratio d/b taking in this case the ratio of areas $0.5 \times 1.813/0.7854 \times 1.813^2 = 0.35$, is $k = 2.3$. The stress concentration factor with $q = 0.4$, by expression (8),

$$k' = 1 + 0.4(2.3 - 1) = 1.52$$

practically the same as was estimated. Thus no changes are required. Evidently the change from d_2 to d_1 must be very gradual, in order not to introduce a new stress concentration.

It is advisable to check the obtained dimension in respect to the actual stresses and safety factor.

The nominal stress in the 1⅛ inch section is

$$s = 200/(0.7854 \times 1.125^2) = 201 \text{ psi}$$

The impact stress, by expression (15),

$$s' = 201[1 + \sqrt{1 + (2 \times 2 \times 30{,}000{,}000)/(201 \times 60)}] = 20{,}300 \text{ psi}$$

According to expression (18)

$$U = (20{,}300^2 \times 0.7854 \times 1.125^2 \times 60) / (2 \times 30{,}000{,}000) = 410 \text{ in.-lb.}$$

To find the actual safety factor, the corrected elastic limit must be determined. The size coefficient, by expression (5), (M D. June, p. 17).

$$c_{sz} = 1 - 0.4(1 - 0.85)(1.813 - 0.5) = 0.921$$

This gives $S_e' = 42{,}000 \times 0.921 = 38{,}700$ pounds per square inch and the actual safety factor

$$f' = S_e'/s' = 38{,}700/20{,}300 = 1.91$$

Another way to find f' is to find the maximum stress s_{max} which can be created in the main part of the rod without exceeding the elastic limit in the section weakened by the pin hole and stress concentration. Since the stress are inversely proportional to the cross areas, therefore

$$s_{max} = (38{,}700/1.52)(0.7854^2 \times 1.813^2 - 0.5 \times 1.813) / (0.7854 \times 1.125^2) = 42{,}850 \text{ psi}$$

Since s_{max} is greater than S_e', the latter value must be used.

The maximum energy which could be absorbed without exceeding the elastic limit at any point is

$$U = (38{,}700^2 \times 0.7854 \times 1.125^3 \times 60) / (2 \times 30{,}000{,}000) = 1496 \text{ in.-lb.}$$

and the actual safety factor, by expression (12).

$$f' = \sqrt{1496/406} = 1.92$$

EXAMPLE 3.—Determine what will happen if the tie rod in *Fig.* 16 is made throughout with the same diameter $d_1 = 1\text{-}13/16$ inches to simplify manufacturing.

In this case the maximum stress in the unweakened part will be lower,

$$s_{max} = (38{,}700/1.52)(0.7854 \times 1.813^2 - 0.5 \times 1.813) / (0.7854 \times 1.813^2) = 16{,}500 \text{ psi}$$

The resilience becomes

$$U = (16{,}500^2 \times 0.7854 \times 1.813^2 \times 60) / (2 \times 30{,}200{,}000) = 697 \text{ in.-lb.}$$

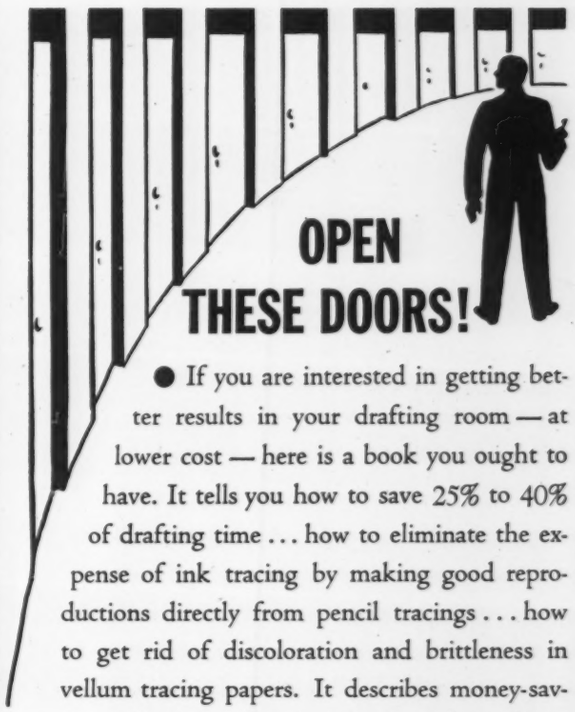
and the actual safety factor by expression (21)

$$f' = \sqrt{697/406} = 1.31$$

This brings out the great difference in designing a member to resist impact as compared to static loading: An increase of a cross-sectional area does not strengthen a member, but instead weakens it.

Repeated loads and endurance limits are two factors which have caused considerable difficulty in the past. In the next section of this treatise these two factors will be considered in detail, while applications of the formulas to design problems will be given in the concluding section of the series in the September issue.

To be continued in the August issue.



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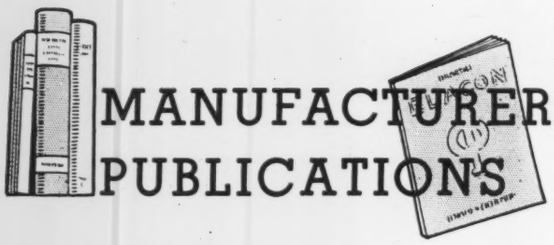

MANUFACTURERS' PUBLICATIONS

ALLOYS (STEEL)—Timken Steel & Tube Co., Canton, O., has just issued a revised copy of its sheet listing "Timken Steel Specifications." In addition to the range of alloy and carbon steels listed under SAE classifications, this specification sheet also gives the specifications for Krupp, Ni-Cr-V and the special corrosion and heat resisting steels produced by the company.

ALUMINUM—Aluminum Co. of America, Pittsburgh, has issued a completely revised edition of its booklet "Alcoa Aluminum and Its Alloys." The booklet contains an engineering description of the alloys including all properties, and complete tables on each of the available alloys.

BEARINGS—The third edition of *Timken Engineering Journal* has just been issued by Timken Roller Bearing Co., Canton, O. This 260 page loose leaf publication covers the design of the company's bearings with illustrations of the various types, a discussion of ratings, curves and factors which apply for speed, life expectancy, engine torque, use or application and typical examples of load calculations and bearing selection. Copies may be secured by engineers, designers and executives who request them on company letterhead giving title and connection.

BEARINGS—New Departure Mfg. Co., Bristol, Conn., is distributing the tenth edition of its catalog on ball bearings. This catalog presents complete listings of new bearing types and new sizes of existing types in addition to many helpful features for engineers and designers such as tolerances and mounting fits for standard, precision and ultra-precision bearings; bearing closure data; and approved methods of bearing selection. Also included are data on standard locknuts and lockwashers, felt seals and other seals, and complete equivalent tables.

BEARINGS—A wide scope of bearing information is included in the 76-page edition of Engineering Data Sheets just published by SKF Industries Inc., Philadelphia. Subjects include selection, mounting and lubrication of ball and roller bearings; descriptions and illustrations of many types of bearings; conversion tables; transmission appliances; and tables showing principal dimensions, shaft fits and tolerances, housing fits and tolerances, removable sleeves, shaft locknuts and lockwashers, corner radii and shaft fillets.

BRAKE BLOCKS—A folder on Thermo brake blocks has been made available by Thermoid Co., Trenton, N. J., giving complete information on these blocks.

CONTROLS (ELECTRICAL)—Safety switches especially suited for industrial applications are presented in a new bulletin of Electric Controller & Mfg. Co., Cleveland. These switches are of the quick-make, quick-break type and are available in weather proof and dust tight enclosures.

DRIVES—Infinitely variable speed at any point between 5 and 750 revolutions per minute is provided by the hydraulic transmission described in bulletin 35-T8 of Vickers Inc., Detroit. Hydraulic, electrical or mechanical remote control can be employed with the transmissions.

DRIVES—The application of power to the work including a discussion of individual motor and modern group

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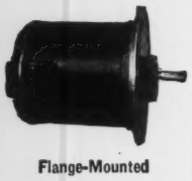

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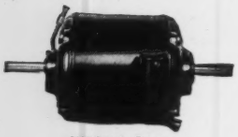

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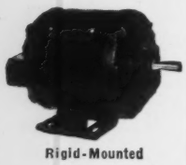

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In 1/4 horsepower ratings of the repulsion-start-induction motor, shaft height and dimensions will vary slightly from the other ratings.

At the left are illustrated four of several types of mountings preferred by machinery manufacturers. Each type of mounting is available on all types of Wagner motors.

There are many other considerations besides interchangeability provided for in Wagner design and construction such as: quietness, dependability, appearance, and performance. Write for Bulletin 167 which discusses these considerations and completely describes Wagner small motors.

MOTORS
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FANS
BRAKES

drives is covered in a 44-page publication of Graton & Knight Co., Worcester, Mass. The importance of the selection of the proper belt is covered and charts and tables useful in figuring the power transmission requirements of any particular machine are included.

HYDRAULIC EQUIPMENT—Hydraulic power units, available in three sizes for drilling, reaming, counterboring, spotfacing and similar operations, are covered in a recent bulletin of Ex-Cell-O Aircraft & Tool Corp., Detroit. The units, self-contained and compact, may be mounted either singly or in multiples.

GEARS—Spaulding Fibre Co. Inc., Tonawanda, N. Y., has assembled in folder form information on laminated gear stock for silent gears. Photographs of gears which can be cut from this stock and physical characteristics are included. Another bulletin of the company gives engineering and design information on gears cut from Spauldite, a laminated phenolic.

MAGNESIUM—Dow Chemical Co., Midland, Mich., has prepared an extensive revision to the Dowmetal data book which covers the surface treatment and painting of Dowmetal. The bulletin gives a complete engineering treatment of the subject. Other recent publications include Dowmetal "J" wrought alloy and Dowmetal "H" sand casting alloy.

MOTORS—Louis Allis Co., Milwaukee, has recently published a special bulletin, No. 601, dealing with the special characteristics and containing other important information regarding electric motors for centrifugals.

PACKING GLANDS AND PACKING—Application of oil seals, where they should be used, and why are comprehensively treated in a new 24-page bulletin of Chicago Rawhide Mfg. Co., Chicago. The well-prepared and attractive bulletin illustrates how oil seals are applied in each of the general divisions of machinery and discusses the function of each element in oil seal construction.

RUBBER—A complete line of standard rubber products for industry including belting, hose, fittings, packing, friction material, molded goods, rubber covered rolls and tanks and many others are presented in the new 56-page general catalog of Manhattan Rubber Mfg. Division of Raybestos-Manhattan Inc., Passaic, N. J. The catalog contains engineering data on many of the products, notably belting.

SHAKERS—A mechanism which produces a back-and forth oscillating movement without being fastened to the frame, floor, or other parts of the building is discussed in a bulletin of Ajax Flexible Coupling Co., Westfield, N. Y. The mechanism is used for screening, tamping or conveying.

SHAPES—Parts which can be produced from standard and special cold drawn shapes are illustrated in a folder of Union Drawn Steel Co., Massillon, O.

SPRINGS—The relative efficiency of various types of springs is covered in the June issue of *The Mainspring*, published by Wallace Barnes Co., Bristol, Conn.

VALVES—Diaphragm valves incorporating several new features of design, particularly the arrangement for adjusting the spring pressures, are presented in bulletin No. 1117 of C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. The bulletin gives application data and a complete description of the valves in the line.

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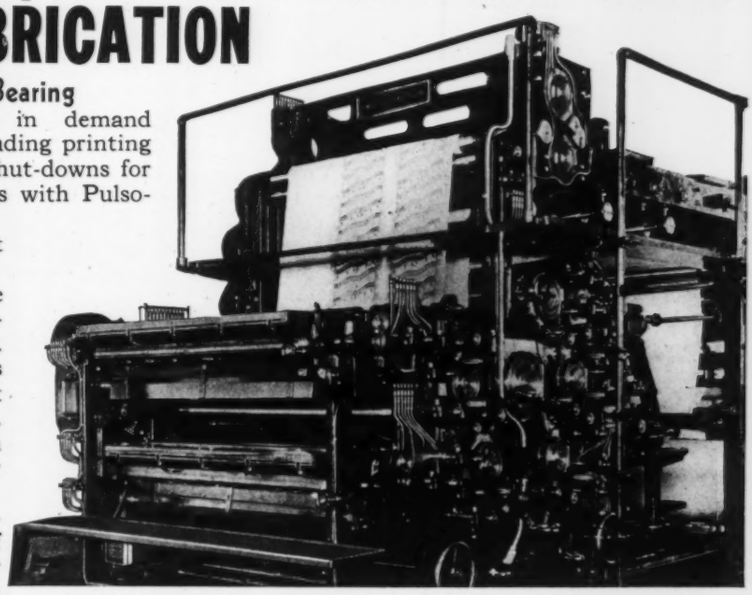

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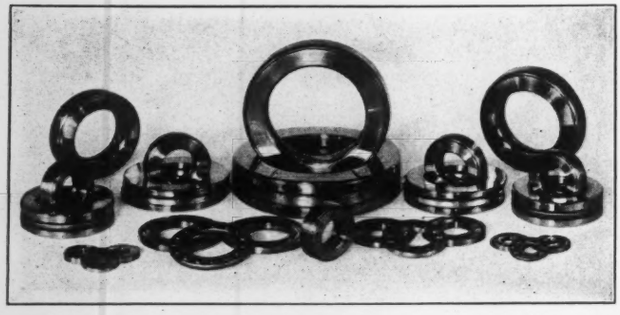

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MACHINE DESIGN **is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.**

—Cross Sections—

HOW NEW are the data sheets on parts which you have in your files? Check them over, the dates on some of them will amaze you! If you wish, we will be pleased to arrange to have up-to-date manufacturers' data sheets on any parts you may use in your machine sent to you. Practically all such information over six months old has been obsoleted by the rapid advances in manufacturing and research of the last few years. Send us your address and company connection and we'll help you build up your files.

ONE OF the most important jobs for designers is to devise mechanisms that the sales department can use to *prove* that the machine or part being merchandised is worthy of the buyer's consideration. We saw an example of just such a device the other day. It was a little arrangement that included two flexible couplings, and the output and input shafts were way out of line in every conceivable direction. The mechanism showed that even with this gross misalignment there was no shaft whip or lost motion. It would pay all designers to aid their sales departments in this manner.

FOR YEARS, both publicly and privately we have been deriding those persons who blame all the troubles of the world on the Machine Age, and we've had some fine documentary evidence to back up our claims. But now we're beginning to have our doubts. There has been developed a "manicuring machine" which consists of a motor-driven wheel with a small disk of abrasive mounted on the face. The wheel is mounted in a holder which is connected to the motor unit by a flexible shaft. If this machine eliminates any of those swell blonds that know just how to hold a hand, we're agin it and will renounce the entire trend toward machines!

ARE YOU planning to be in Cleveland for the Machine Tool Exposition, Sept. 11-21? This exhibition will be the largest display of machinery and parts ever held in this country. Every designer will be able to profit by the new designs and new ideas. We will, of course, be at the show, but if you don't happen to catch us, drop in at our offices just two blocks away, at West Third and Lakeside. Our September issue is to be devoted primarily to machine tools and their component parts. Watch for it! We'll report the show in the October issue for you if you can't possibly be there.

IF YOUR car, like ours, dates back to the halleluiah days, you, also, are probably all too conscious of the marvelous values in this year's cars. Our friends the Technocrats would have us believe that such values are only achieved by squeezing the worker. But let's take a look. The average hourly rate paid in the peak year, 1929, was 71.2 cents. For the twelve months from April, 1934, to March, 1935, inclusive, the average was 75.1 cents. Greatly improved cars at practically unchanged prices were made possible by more efficient manufacturing processes. The machine designer should take a bow.

AIR conditioning shares with electrical refrigeration the idea of demonstrating the designer's ability to create a market for outstanding machines throughout a depression, but how many of us can define exactly what this youngest addition to the machine family does? Westinghouse tells us "To define in a simple language we might say air conditioning is a process which warms air when it is too cold, cools it when too hot, dampens it when too dry, dries it when too wet, and cleanses it when laden with dust and dirt." Quite a contract.

Business and Sales Briefs

LOUIS ALLIS CO., Milwaukee, manufacturer of electric motors, has appointed Harris-Green Co., 1101 Farmers Bank building, Pittsburgh, as engineering sales representatives in the western Pennsylvania territory. The Harris-Green company is a newly organized corporation composed of G. N. Harris and J. G. Green. Associated with them is Henry Harris.

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Inland Steel Co., Chicago, has appointed Charles R. Robinson as vice president and general manager of sales, succeeding Edward M. Adams who died on May 8.

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Ralph W. Kempsmith has been appointed assistant manager of sales in the Cleveland district for Bethlehem Steel Co.

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Harnischfeger Corp., Milwaukee, has appointed Charles W. Daniels as general sales manager for P&H-Hansen arc welders and other equipment manufactured by the company.

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National Motor Bearing Co., Inc., Oakland, Calif., has been awarded the verdict in a patent infringement suit involving a patent for an oil sealing device manufactured by the company.

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Kirkby Machinery & Supply Co., 20-22 St. Clair street, Toledo, O., has been added to the list of distributors of Diamond Chain & Mfg. Co., Indianapolis. Stocks of roller chains of various pitches, sprockets and flexible couplings are carried.

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Bantam Ball Bearing Co., South Bend, Ind., has placed a contract for an addition to its plant which will enlarge the company's floor space by 60 per cent. The addition is planned to augment the company's facilities to accommodate increased business.

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Link-Belt Co., New York, has appointed Woodward & McMillan, Aptdo. 1691 Edificio Metropolitana, Havana, as exclusive representatives for the sale of industrial elevating, conveying and power transmitting chains and machinery in Cuba.

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Harold L. Geiger has been added to the field staff of the development and research department of International Nickel Co. For a few months Mr. Geiger will work out of the Detroit office of the company located in the General Motors building. Later, he will make his headquarters in New York.

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Timken Steel & Tube Co., Canton, O., has appointed S. D. Williams as manager of tube sales with headquarters at Canton. Mr. Williams, formerly assistant director of sales, has been associated with the Timken company since 1926.